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An Illustrated Weekly Journal.

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See advertisement page 19.
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AUTOMATIC FEED REGULATORS.
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Specification and Workmanship equal to Main Line Locomotives.
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Sole Licensees in Great Britain for the manufacture of "Armco" Rust and Corrosion Resisting Iron Tubes. 2267
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Tubes AND Fittings
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Steel Plates.
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See Advertisement, page 83. 1872

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See Advertisement, page 49, Oct. 10.

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Railway, Colliery, Mining and General Engineers, are PREPARED to UNDERTAKE the MANUFACTURE of NEW SPECIALITIES suited to their plant and tools.
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LAND AND MARINE
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Matthew Paul & Co., Ltd.,
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See Full Page Advts., page 44, Oct. 10.

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HALESOWEN. 7116

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For Production of SHEET METAL WORK, COINAGE, CARTRIDGES AND GUNPOWDER.
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See Advert., page 79, Oct. 10. 8195

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RUNWAY (New) FOR SALE, Herbert Morris, cage operated, packed as just delivered, 230 feet with one bend, approximate height 28 feet. With or without 3 phase Motors 220 volts. Magnificent plant. Will sell at 25 per cent. sacrifice.—Apply, C. L. STIFF & CO., LTD., Slag Breakers, East Ardsley, near Wakefield. F 672

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FOR IMMEDIATE DELIVERY.

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The Manchester Steam Users' Association.

For the prevention of Steam Boiler Explosions and for the attainment of Economy in the Application of Steam. 9, Mount Street, Manchester.

Chief Engineer: C. E. Stromeyer, M.I.C.E.

Founded 1854 by Sir William Fairbairn.

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Special Postal Course in Engineering Drafting. Enrol now. Fee Three Guineas for the complete course. Also day tuition in Office by qualified teacher. Established in 1895.—PERCY PITMAN, M.I.Mech.E., 25, Victoria Street, London, S.W.1. 2297

TENDERS.

CORPORATION OF CROYDON, ELECTRICITY DEPARTMENT.

Tenders are Invited for the

following PLANT and EQUIPMENT at the Power Station :—

(a) Railway Siding (400 feet double track).

(b) Weighbridge, Wagon Tipler and Coal-conveying Plant.

The site may be inspected and details obtained from

THE ENGINEER & MANAGER,
Factory Lane, Croydon. G 108

TENDERS FOR THE CONSTRUCTION OF HOPPER BARGES.

The Poole Harbour Commissioners are prepared to consider

Tenders for Construction of

TWO DUMB HOPPER BARGES, of about 300 tons capacity, to be built of steel.

Tenderers to submit their own specification and to state date of delivery and price at Poole.

Tenders and full specification to be forwarded to the undersigned not later than Tuesday the 28th inst.

R. M. MANSER,
Clerk to the Harbour Commissioners,
Poole, Dorset. G 110

WICK HARBOUR.

WEIGHBRIDGE FOR SALE.

The Steel Weighbridge, by

H. Pooley & Sons (which weighs up to Five Tons), on the North Pier of the Harbour, and is being replaced by a larger machine, is FOR SALE by Private Bargain. Full particulars may be obtained from the subscriber, with whom offers, marked "Offer for Weighbridge," must be lodged not later than 31st inst.

W. B. WOOKEY,
Harbour Engineer.
Wick,
1st October, 1924. G 52

BENGAL-NAGPUR RAILWAY COMPANY LIMITED.

The Directors are prepared to receive

Tenders for :—

4,243 TONS STEEL, FLAT-BOTTOM RAILS, 90 lbs. PER YARD.

Specification and Form of Tender can be obtained at the Company's offices, 132, Gresham House, Old Broad Street, E.C. 2, on or after 10th October, 1924.

A fee of Twenty Shillings will be charged for the specification, which is NOT returnable.

Tenders must be submitted not later than NOON on Saturday, 18th October, 1924.

The Directors do not bind themselves to accept the lowest or any Tender, and reserve to themselves the right of reducing or dividing the order.

By order of the Board,
R. C. VOLKERS,
Secretary G 105

EPSOM URBAN DISTRICT COUNCIL.

WATERWORKS.

NEW BORING.

The Epsom Urban District Council are prepared to receive

Tenders for the Sinking of a

BORING, with Lining Tubes 30 inches in diameter, at the Waterworks, East Street, Epsom.

Contractors, who must be on the King's Roll, desirous of tendering may obtain copies of the Specification, General Conditions, and Form of Tender from the Office of Mr. W. Vaux Graham, M.Inst.C.E., 5, Queen Anne's Gate, Westminster, S.W.1, on payment of the sum of Two Guineas, which will be returned on receipt of a *bona fide* Tender.

Tenders, endorsed "Tender for New Boring," must be sealed and addressed to the Clerk of the Council, 37, Church St eet, Epsom, so as to reach him not later than first post on Monday, October 27th, 1924.

The Council do not bind themselves to accept the lowest or any Tender.

E. G. WILSON,
Clerk.
37, Church Street,
Epsom. G 103

BOLTON UNION.

For Sale, Manlove, Alliott

STEAM DISINFECTOR, complete with Vertical Boiler fitted with Injector. The apparatus has been in daily use until June last being under insurance for 60 lbs. pressure.

The capacity of the chamber of the Disinfector is about 50 ft.

The apparatus may be seen at the Fishpool Institution, Farnworth, Near Bolton.

Offers to be sent to the undersigned not later than the 28th instant.

H. I. COOPER,
Clerk to the Guardians.
28, Mawdsley Street, Bolton.
13th October, 1924. G 153

SIAM STATE RAILWAYS.

NOTICE.

Tenders are Invited for the

SUPPLY of 260 PAIRS of CARRIAGE and WAGON BUFFERS WITH SIDE CHAINS.

Specifications and Drawings may be obtained against payment of £1 from Messrs. C. P. Sandberg, 40, Grosvenor Gardens, London, S.W.1.

Sealed Tenders, with the inscription "Tender for the Supply of Carriage and Wagon Buffers with Side Chains, B.E. 2467" must be forwarded to the undersigned, at whose office in Bangkok, Siam, they will be received up to 14 o'clock on the 15th January, 1925, at which place and hour the Tenders will be publicly opened and read.

Right is reserved to reject any or all Tenders, and to accept any Tender which in the opinion of the under-signed is to the best interest of the Siam State Railways.

Department of State Railways,
BANGKOK. G 128
(SGD.) ACTING COMMISSIONER GENERAL.

EPSOM URBAN DISTRICT COUNCIL.

WATERWORKS.

ADDITIONAL PUMPING PLANT.

The Epsom Urban District Council are prepared to receive

Tenders for the Provision,

ERECTION, and SETTING TO WORK of a COMPLETE PUMPING PLANT of British Manufacture, consisting of a Centrifugal Borehole Pump and a High Lift Pump actuated by an Internal Combustion Engine, with all the necessary accessories and spare parts.

Contractors, who must be on the King's Roll, desirous of tendering may obtain a copy of the Specification, General Conditions, and Form of Tender from the office of Mr. W. Vaux Graham, M.Inst.C.E., 5, Queen Anne's Gate, Westminster, S.W.1, on payment of Five Pounds which will be returned on receipt of a *bona fide* Tender.

Tenders endorsed "Tender for Additional Pumping Plant," must be sealed and addressed to the Clerk of the Council, 37, Church Street, Epsom, so as to reach him not later than first post on Monday, November 24th, 1924.

The Council do not bind themselves to accept the lowest or any Tender.

E. G. WILSON,
Clerk.
37, Church Street,
Epsom. G 152

THE MUNCIPALITY OF SINGAPORE. TENDERS FOR STEEL PIPES, VALVES, &c.

Sealed Tenders, Addressed to

Messrs. C. C. Lindsay & Peirce, 180, Hope Street, Glasgow (Agents to the Municipality of Singapore) endorsed "Singapore Municipality — Tender for Steel Pipes, Valves, etc ." will be received until Five p.m. on Friday, the 31st October, 1924, for the SUPPLY and DELIVERY at Singapore of about SIX MILES of WELDED STEEL PIPE, 33 inches internal diameter; about SIX MILES of WELDED STEEL PIPE 36 inches internal diameter; about SIX MILES of WELDED STEEL PIPE 39 inches internal diameter, together with certain CAST IRON PIPES, VALVES, and SPECIALS. Though Lap-Welded Steel Pipes are specified, Tenderers are at liberty to offer other makes of steel pipes, but riveted pipes will not be accepted, and whatever make of pipe may be offered must be of British Material and manufacture. Forms of Tender and Specification may be obtained on and after the 10th October, 1924, from Sir Alex. Binnie Son and Deacon, 30, Buckingham Gate, Westminster, S.W.1, or from the Agents to the Municipality, on receipt by either of them of a cheque to the value of £5, made out to the Agents, Messrs C. C. Lindsay and Peirce, which amount will be returned on receipt of a *bona fide* Tender. Drawings may be seen at the offices of Messrs. Sir Alex. Binnie Son and Deacon. The lowest or any Tender will not necessarily be accepted nor will any expenses in connection with Tendering be defrayed. No Tenders will be considered except from actual manufacturers, capable of supplying the sizes at the rate of 90 of each size per long with a proportion

C
(Age

G 65

APPOINTMENTS OPEN.

SOUTH AFRICA.

UNIVERSITY OF CAPE TOWN.

A Lecturer in Mechanical

Engineering is REQUIRED for a period of twelve months, commencing March 1st, 1925.

Candidates must be qualified to take first three years classes in Machine Drawing and Design, and lectures on Theory of Machines

Teaching and Drawing Office experience essential. Payment £400.

Applications, stating age, qualifications and experience, together with copies of not more than three recent testimonials must be sent to

PROF. SILLICK,
Royal College of Science,
London, S.W.7,

so as to reach him not later than Friday, November 7th, 1924. G 150

Civil Engineer Required

by the GOVERNMENT of NIGERIA for service as an Assistant Engineer in the PUBLIC WORKS DEPARTMENT, for two tours of not less than 12 months' nor more than 18 months' service with possible extension. Salary £720, rising to £920 a year by annual increments of £40. Free quarters and passages and liberal leave on full salary. Candidates, aged 30-35, must be fully qualified Civil Engineers, holding A.M.I.C.E. or equivalent professional qualifications, and have had considerable experience (preferably in charge) on large Engineering or Municipal Works. Preference given to candidates with experience on Water-works construction.—Apply at once by letter, stating age, qualifications and experience, to THE CROWN AGENTS FOR THE COLONIES, 4, Millbank, London, S.W.1, quoting reference M/13154. G 129

Two Research Assistants

(Senior and Junior) WANTED to carry out a Research upon blast furnace reactions at the Imperial College of Science and Technology, London, under the direction of Professor W. A. Bone, F.R.S., on behalf of the National Federation of Iron and Steel Manufacturers. A good knowledge of Physical Chemistry and Gas Analysis and manipulation essential. Salaries from £240 to £360 per annum according to qualifications.—Applications, with recent testimonials, should reach the DIRECTOR OF THE FEDERATION, Caxton House, Tothill Street, S.W.1, on or before Monday, October 27th next. G 78

Applications are Invited

for the Vacant POST of TECHNICAL ASSISTANT at the Admiralty Research Laboratory, Teddington. Candidates must be natural-born British subjects and preference will be given to ex-service men. The qualifications required are a sound theoretical knowledge of electrical engineering and some experience in experimental or research work. The salary attaching to the post is £140 10s. to £190 per annum plus Civil Service bonus. The present value of £140 equals £225 1s. per annum.—Applications should be made to the SUPERINTENDENT, Admiralty Research Laboratory, Teddington, not later than the 30th October, 1924. G 151

Assistants (Two) Re-

QUIRED by the GOVERNMENT of CEYLON for service in the Architectural Office of the PUBLIC WORKS DEPARTMENT for a period of three years with possible permanency.

Salary £500, rising to £560 a year by annual increments of £30 and thence (if appointment is made permanent) to £960 a year, payable locally in rupees at the Government rate of exchange of 15 rupees to the £. Free passages. Candidates, preferably unmarried, aged 26 - 30, must have passed the examination for Associate Membership of the R.I.B.A., or for the Membership of the Society of Architects, and have had special experience in the actual design and construction of reinforced concrete buildings, and of steel frame buildings.—Apply at once by letter, stating age, qualifications and experience, to THE CROWN AGENTS FOR THE COLONIES, 4, Millbank Westminster, S.W.1, quoting M/12945. G 120

Section Engineers Re-

QUIRED for the CONSTRUCTION BRANCH of the FEDERATED MALAY STATES RAILWAYS for four years' service with possible permanency. Salary $400 a month rising to $475 a month by annual increments of $25, a month plus a temporary non-pensionable allowance of 10% which is liable to cancellation or revision, plus a commuted Field Allowance of $50 a month. The exchange value of the dollar in sterling is at present fixed by the Government at 2s. 4d., but its purchasing power in Malaya is at present considerably less than that of 2s. 4d. in the United Kingdom. Free passage provided. On expiration of agreement a bonus of six months' salary may be allowed provided the work and conduct of the person engaged has been in every way satisfactory. Candidates, age, 30 to 38 and unmarried, must be fully qualified Railway Engineers who have received good training and experience on recognised European, American or Colonial Railways. Members or Associate Members of the Institution of Civil Engineers, preferred.—Apply, at once, by letter, stating age, whether married or single, and particulars of qualifications and experience, to THE CROWN AGENTS FOR THE COLONIES, 4, Millbank, Westminster, S.W.1, quoting at top of application M/12797. G 149

JODHPUR BIKANER RAILWAY.

JUNIOR LOCOMOTIVE OFFICER.

Messrs. RENDEL, PALMER & TRITTON, Consulting Engineers to the above Railway, are prepared to receive

Applications (by Letter only)

[illegible] duly qualified candidates for APPOINTMENT to the above VACANCY.

Applicants must be Public School men, about 25 years of age and unmarried, and must have a good technical education at some recognised Engineering College, and have passed the Associate Membership Examination of the Institution of Civil Engineers, or the Associate Membership Examination of the Institution of Mechanical Engineers, and have served either a pupilage or apprenticeship in Locomotive Shops in the United Kingdom, together with some drawing office experience. Preference will be given to one who has also had experience in the running department, and/or of traffic working.

Salary :—Rs. 525 per Calender month to commence, rising according to the scale laid down by Government of India Rules (approximately Rs. 50 per month annually). Salary commences on day of embarkation for India.

Terms :—A three years' agreement in the first instance, first-class free passage to India, and by rail to Jodhpur. The selected candidate will be required to pass a strict medical examination before final appointment.

Letters of application, giving the candidate's age, details of general and technical education, training and subsequent career (in chronological order), with dates, accompanied by COPIES ONLY of testimonials, Army Certificates, etc., should be addressed to Messrs. RENDEL, PALMER & TRITTON, Appointments Dept., 12-14, Dartmouth Street, Westminster, S.W.1, not later than 27th October, 1924. G 148

GLOUCESTER COUNTY COUNCIL.

TRUNK ROAD RECONSTRUCTION SCHEME.

The Services of a few Tempo-

RARY ENGINEERING ASSISTANTS, salary £6 per week, also two Temporary Clerical Assistants, salary £3 per week, are required for the above, for a period of about 18 months.

Applicants for the post of Temporary Engineering Assistants must be trained Civil Engineers with road construction experience, particularly in respect of asphalt surfaces. Preference will be given to ex-service men who served overseas in the late war.

Applications to be sent in not later than Monday, the 27th instant, and to be made on forms which can be obtained from the

COUNTY SURVEYOR,
Shire Hall, Gloucester. G 146

Assistant Engineer Wanted

for erection and maintenance of plant; good draughtsman and able to handle correspondence preference to one having knowledge of steel structure, conveying, contractors' plant and furnace work. Give full particulars, experience, age and salary asked.

Address, G 157, Offices of ENGINEERING.

Estimator, with Wide Experi-

ence in ship repairing, WANTED for Liverpool District. — Address, G 122, Offices of ENGINEERING.

Works Manager or Superin-

tendent for Electrical Switch and Control Gear Factory; of sound qualification, experience of modern production methods, tools, processes and with executive and organising ability. Used to accurate mass production of small parts. Good all-round electrical knowledge an advantage.—Write, fullest details, salary, etc., BOX 1929, Sells Advertising Offices, Fleet Street, E.C.4. G 124

Experienced Sales Repre-

SENTATIVE REQUIRED by leading firm in Lift Trade. Sound Engineering and Commercial training essential.—Address, in first instance, giving full details of qualifications, experience, age, and salary, G 37, Offices of ENGINEERING.

Electric Crane Expert for

Estimates and Technical Correspondence. Age 30/40. Give full particulars and salary in confidence. — Address, G 138, Offices of ENGINEERING.

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RELATIVITY.

During the recent visit of the British Association in Canada, Professor A. S. Eddington, F.R.S., who, after Einstein, is probably the ablest exponent of the theory of relativity, undertook the difficult task of explaining the elements of the theory to popular audiences. The interest taken in the subject was shown by the crowds, both in Toronto and in Victoria, B.C., who were attracted by the lectures which, if not breaking new ground, at least upheld the best traditions of the association by proving that the most difficult branches of science can be presented in a form which enables ordinary persons to keep in touch with scientific thought, provided that the lecturer, as in this case, has the necessary, but rare, qualifications for the purpose.

To prepare his audiences for the revolutionary ideas which the theory of relativity involves, Professor Eddington commenced his lecture by calling their attention to the way in which science had repeatedly attacked the commonplace conception of things and substituted entirely different views. When the lecturer, like any other human being, stepped upon the platform to address them he apparently performed no extraordinary feat, yet from the scientific point of view there he was—a collection of molecules with relatively enormous spaces between them—kept in an average position by the bombardment of another set of molecules constituting another aggregate—the boards on which he stood. Furthermore, he was hanging, head outwards, from a large sphere (the earth) rotating rapidly and also travelling through space with enormous velocity. That this was a reasonably correct picture of his condition while addressing them, no one doubted, yet how different it appeared from their every-day conceptions. It was not arrived at by any process of directly disproving the ordinary view, but by dispassionately reviewing all the evidence bearing on the case. Similarly, the astronomer was not concerned to prove that the ordinary traditional ideas were wrong, but to devise a way of looking at things which should take into account all facts which were demonstrably true.

Professor Eddington introduced the real subject of his lecture by considering what he termed the "experimental fact" that a moving rod shortened in the direction of its motion. The term may seem to some of our readers rather a strong one, but is justified by the result of the famous Michelson-Morley experiment which seems to leave room for no other conclusion. This experiment, which was first performed in 1887, was repeated in 1905 with the same results, and has again been verified more recently. A rod on the surface of the earth moving longitudinally with the earth's speed of 19 miles per second would be shorter by one part in 200 million than if it were at rest. Such shortening not only followed as a necessity from the Michelson Morley experiment, but could also be predicted on other grounds by the accepted laws of physics. The electrical forces of cohesion which retained the molecules of matter at their normal distances were modified by motion, with the result that a moving rod was shorter than a stationary one. The contraction of a moving body might therefore be taken as definitely established by the ordinary laws of physics which were accepted by everyone.

We had next to consider the consequences of this fact, which were certainly remarkable. Supposing a planet to be moving through space at a speed of 160,000 miles per second. As the planet rotated on its axis a man would vary in height from 3 ft. to 6 ft. while the planet made a quarter of a revolution, and a 100-mile journey would shorten to 50 miles in the same time. As the man's footsteps and measuring devices would lengthen and shorten exactly as the distance varied he would have no means of finding out by himself that anything was happening at all. We knew of no heavenly bodies moving with such a speed as that mentioned, but there was certainly a spiral nebula, travelling at 1,000 miles per second. This speed was quite high enough to alter lengths sufficiently to affect engineering and scientific measurements according to their direction. How annoyed an observer on the nebula would be when he first discovered this, and how thankful we ought to be that the earth travelled along at a decent speed. But was our self-congratulation justified? The nebular observer would say that it was we who were rushing through space at 1,000 miles per second and that our measurements were all wrong while his were right. In the nature of things neither party could possibly discover the errors which the other attributed to his observations. The dilemma was serious and far-reaching. Scientists on the earth and on the nebula respectively would agree about nothing. If we constructed a square it would look oblong to them and *vice-versa*. They would locate the stars in positions which we would not admit. In fact, each of us would be using a different "frame of space" and the one's location of things would be like a distorted map to the other. The clocks, measuring rods, electric fields, &c., of each observer are all distorted from the point of view of the other but the "errors" of all the measurements of the same observer cancel out so that the wrong frame of space, if either can be called wrong, acts just as well for those who use it, as if it were right according to the notions of other people.

As Professor Eddington pointed out, the absurdities, if they could be so called, to which he had called attention, had nothing to do with Einstein or his theory. They arose from experiments and facts admitted by opponents as well as by advocates of the theory of relativity. The facts regarding the observer on the nebula had led to the conclusion that there must be two different frames of space, both of which would work equally well, and, of course there could be an indefinite number of other frames. What Einstein had said, was that none of these frames was more justifiable than any other. We mortals had assumed that there must be one unique "right" frame, without saying in what its rightness consisted. We had selected the one in which we and our petty affairs occupied the central position. Einstein asked us to abandon our parochial outlook, to complete the revolution in thought begun by Copernicus and to regard the universe from an external position. Length, which like mass and time, we had been taught to regard as some absolute thing, was nothing of the kind. It was the result of an operation of measurement carried out by prescribed rules, but what thing was correlated to the result of the measurement we could not conceive. The difference between absolute and relative quantities must be kept clearly in view. The number of people in the room was an absolute quantity, quite independent of the position or motion of the observer. The direction of a city was relative, to one man it might be east, and to another west. Length used to be considered absolute, but we now knew that a rod which had one length relative to measurements made on the earth, would have another length if considered in relation to the space-frame of Venus for example. Length, in fact, like direction, varied according to the position and motion of the observer.

To drive this point home to his audience, Professor Eddington gave a humorous illustration. He supposed that two of his assistants had been asked to determine with great care the exact distance between two points on the platform. They could not get their results to agree, as one maintained that it was right to make the measurements according to the terrestrial space frame, while the other had adopted the view-point of Plaskett's Star, as being the most massive, and therefore presumably the most important, body in the universe. After chiding them for not having both considered their instruments as partaking of the same motion through space as the platform, and thus securing consistent results, he asked them to go and measure the wave-length of the wireless radiations, by means of which his speech was being broadcasted. They returned saying that their results were in perfect agreement, both finding the length of the waves to be infinite. Asked how this could be, in view of the fact that the wave-length was advertised as about 300 metres, they replied that at great trouble and expense they had acted on the principle he had laid down and had seen their apparatus hurtling through space at the rate of 186,000 miles per second, so that it should keep up with the waves. The consequence had been that the measuring apparatus had contracted to infinitely small dimensions and had, therefore, produced the results mentioned.

There was nothing in any way mysterious about the "fourth dimension." It was obvious to everyone that the world of solid permanent objects could be regarded as comprising "up and down" "right and left," "backward and forward," in other words things existed in a three-fold order. It was equally obvious that the world of events was four-dimensioned, because the question of "sooner or later" had also to be considered. The British Association meeting at Toronto, relative to the previous one at Liverpool was so many miles west, so many miles south, so many feet higher, and so many months later. Four dimensions were, therefore required to fix a thing in the world of events. Nothing more than this was meant by a four-dimensioned world. "Sooner and later" was quite a different relation from "up and down," but this also was different in its way from "right and left." Why, it might be asked did the relativists, resurrect the ancient and simple truism about the fourfold order of events? In general, little attention had been paid to it because there was no need to associate the three-fold order of space with the one-fold order of time. But the possibility of this separation was due entirely to the fact that we lived on a planet with a particular kind of motion. In the nebula previously mentioned, the separation into a three-fold and a one-fold order was made in a different way. The possibility of different divisions would be evident from the fact that the words vertical and horizontal described different directions according to whether the person using them were, for example, in Canada or England. An infinite choice of frames arose from the possibility of slicing the four-fold world in different ways, but to see the universe in its true simplicity we must not slice it, but regard it as a four-dimensioned whole.

In our ordinary mode of thought we analysed the world into a succession of instantaneous states. We regarded instants as extending through all space, and the world as going on from instant to instant. Piling these instants on one another, we got an idea of the whole world of events. The enduring world appeared to us as if it were stratified into instants. The actual lines of structure did not necessarily follow any such scheme any more than the geological formation of the earth corresponded with the lines of longitude or latitude on a map. An observer of another star would use a different direction of stratification or a different division into instants as being more convenient according to his own motion, and he would be entirely at liberty to do so, since these artificial divisions, convenient as they were, did not in any way indicate the structure of the world outside us. They were merely our scaffolding for inspecting it and not part of the structure.

The theory of relativity, Professor Eddington continued, revealed the simplicity of the world outside us, which was obscured because our mental eye was distracted by the irrelevant lines of partition we had drawn across it for our own convenience. But although the world with the stratification removed was simpler it was more unfamiliar. A clear distinction had to be drawn between simplicity and familiarity. A pig, as stratified into rashers might be much more familiar to a biologist than in its natural state, but if he wished to discover how the animal functioned he would find the study of the complete pig much simpler and more conducive to results than a study of the rashers.

The theory of relativity as so far outlined was promulgated by Einstein in 1905, and was called the special theory. The general theory, introducing space curvature and a new law of gravitation was reached by Einstein some ten years later. The idea could best be approached by considering ourselves as being in a lift falling freely down a shaft. Under such conditions we should have frames of space and time differing from those of the earth, and such physical knowledge as we could learn by experiments would be referred to the new frame. The frame was different from any yet considered because the motion was accelerating with respect to the earth. Suppose that, when standing in the descending lift, we dropped an apple. It would

remain suspended in the air showing no tendency to fall to the floor of the lift, so that so far as we were concerned gravitation would appear to have been abolished. Except for this important difference we should find all ordinary physical laws to be the same as on earth. We might then try another experiment, namely, that of dropping two apples simultaneously at opposite corners of the lift. As they both would be on convenient paths to the centre of the earth, we should see them slowly approaching each other although remaining at the same height above the floor of the lift as when we released them. Gravitation would have disappeared, and a new phenomenon, namely, that of a tendency of masses to drift horizontally instead of to fall vertically would have been observed. It would thus be evident that our old notion of gravitation as a definite pull, independent of frames of space and time, could not be maintained. Our picture of the phenomenon must depend upon whether we regarded it from a standpoint on the earth or in the lift, and there was no reason for holding that one position was more correct to take than the other. Whether we preferred to regard gravitation as some sort of pull, or whether we regarded it, as Einstein did, as a curvature of space-time, our description could never be more than that of a mental picture. Our imagination could not rise to the conception of the inscrutable processes of nature in their intrinsic essence.

If the space-time of the falling observer is on an equality with that of the stationary observer, our ideas of gravitation must be reconstructed. Professor Eddington gave it as his own opinion that the standpoint of the man in the lift was the simple one, and by considering the lift-man on an equality with ourselves as an observer of phenomena, we were forced to construct a new picture of gravitation which would not arbitrarily condemn certain of our frames of space time as wrong, and accept others as right, with equal disregard of principles. It was more difficult to see why the picture had taken the form of non-Euclidean geometry, or, in other words, a curvature of space time. The idea might be approached by an analogy. The earth, to the earliest human observers appeared flat, and any view that it was curved would have been rejected as absurd and inconceivable. However, the fact of its curvature was forced upon the mind by the extension of knowledge, and no one now finds any difficulty in conceiving it as spherical. The conception of space-time as curved was a strange one, but it seemed best to fit the case. A curvature or pucker was just the picture we needed for gravitation. It did not exist at a point, no one could say a point was curved, but in the neighbourhood of a point. There was similarly no gravitation at a point. When the apples mentioned above had drifted to the centre of the lift they would stop. Gravitation was a property of the space surrounding a point, and was obvious to all observers whatever their frame of reference.

The use of a geometrical term, such as curvature, for a mechanical force, such as gravitation was, arose in consequence of the unification of geometry of mechanics in consequence of the unity of space and time in a four-dimensional continuum. They could only be divided on artificial lines. The measurement of space was a matter of geometry, and that of time a matter of mechanics, but they could not be dissevered and treated separately. Geometry and mechanics could not be kept apart, hence we had to erect a wide subject which would contain both. This subject came under the heading of geometry because of the wider nomenclatures of this science. There was nothing revolutionary in one sense, in regarding the space time continuum as curved, or in other words as obeying the laws on non-Euclidean geometry. We had for 2,000 years believed that space was Euclidean and were consequently attached to this view, but the idea of a continuum of space time as distinguished from space alone, did not occur to physicists until 15 years ago. Hence we had no tradition as to the geometry of the combination. If the space time continuum had not a Euclidean geometry, our arbitrary section of it called space could only be Euclidean by mere chance. In fact, if Einstein had hit upon the right line of geometry in his law of gravitation our space must be non-Euclidean. The curvature of the time element was, however, the more important consideration.

In concluding his lecture, which had held the earnest attention of a large audience from start to finish, Professor Eddington remarked that the introduction to the subject, which was all that he could attempt under the circumstances, was only the beginning of a long series of developments which had made clear much that was puzzling and obscure in various regions of physics, and had given us a wonderfully unified conception of the forces at work in the world. Mathematicians had not introduced the new and curious way of looking at things simply because the ideas were amusing to contemplate, but because the view-point provided a line of thought which led to the unravelling of some of the mysteries of science. The theory of relativity had justified itself by enabling the prediction of things which could be and had been verified by observation.

INDIA AND BURMA AT THE BRITISH EMPIRE EXHIBITION.

(*Concluded from page* 509.)

Only the most general account can be given of the contents of the individual courts. The Cotton Court represents one of the greatest of Indian industries, the export of raw cotton being nearly half the value of the total exports of raw material and just under a fourth of that of all total exports, and likely to be still larger as the cotton-growing area is increased by irrigation, and a larger proportion is used for producing a longer staple. About a third of the crop is made into yarn and cloth in Indian mills, and cotton manufactures now represent more than a fifth in value of the total manufactured exports and about 6 per cent. of the total export trade.

The Madras Court, which includes the exhibits of the States of Cochin, Banganapalle and Sandur, is among the largest and most varied. Madras has about the same population as Great Britain, and is about half as large again. Some 70 per cent. of its population is engaged on agriculture, the chief crop being rice, the others including cotton, sugar, ground nuts, tea, coffee, and the various herbs and spices that enter into South Indian grocery. It has large industries in coir, cotton, silk, wool, jute and other fibres, and a rich selection of textiles made from them is exhibited. Tanning materials and tanned hides and goat skins also represent an important industry. Models of specimens illustrate a large number of practical native devices, such, for example, as the improvised bridge shown in Fig. 4 for crossing narrow streams, which is cheap, ready and serviceable.

Bengal has rather less area than Great Britain and rather more population, most of whom are connected directly or indirectly with agriculture and produce, chiefly rice; in addition to important productions of tea, tobacco, jute and similar fibres, lac and forest products. All these are fairly represented, and to some extent also are the manufacturing industries that are being actively conducted.

The Bombay Presidency includes in its British districts about twice the area of England and Wales with something over half their population. It has no great mineral resources, but nearly two-thirds of its population are agricultural, producing chiefly wheat and cotton. It includes the remarkable district of Sind, which from being a great desert is being gradually converted by irrigation work into one of the most important cotton fields in the world. Production on the agricultural side is illustrated fairly, and some beautiful examples of artistic fabrics and wares are shown by private exhibitors. So far, however, as concerns the great textile industry of which Bombay is the Indian centre, the representation is quite inadequate. The only considerable exhibit, indeed, is that of the Indian Woollen Mills, which show some of their fabrics. The United Provinces of Agra and Oudh, rather larger than Great Britain and carrying a rather larger population, are principally agricultural. The States of Benares and Rampur are exhibiting in this court, and in numberless ways the traditional aptitude of the population in Benares and elsewhere to give beautiful and elaborate forms to metal and other materials is fully illustrated.

The Punjab, rather larger than the Bombay Presidency and with rather more population, is at present mainly agricultural, owing its prosperity in large measure to the recent development of canal irrigation. Considerable attention is being given to the scientific study of agriculture, and among the exhibits models show some progress in the adoption of mechanical methods. Samples and statistics illustrate the improvement in cotton and other produce. The State of Kapurthala is exhibiting in this Court. An interesting model by Messrs. Ransomes and Rapiers, Limited, shows the Mangla regulator and other works in connection with irrigation, which are further illustrated by maps and plans showing the development that has taken place and the growth of the irrigated districts. Bihar and Orissa, the area and population of which are roughly comparable with those of Great Britain, show mainly silks and other textiles, silver and gold ornaments, and filigree and a few other native arts of great beauty, but give no suggestion of the fact that in iron, steel and coal, and allied industries it is the great manufacturing district of India.

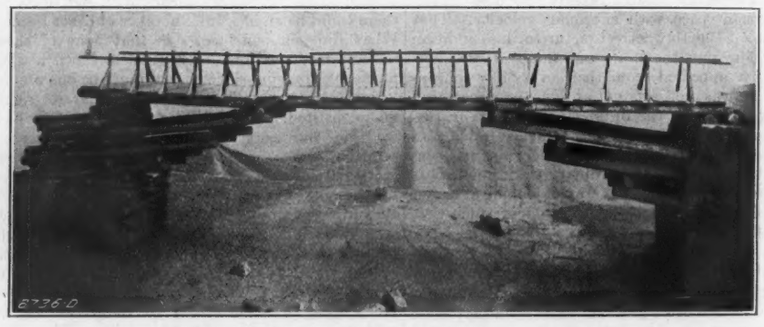


Fig. 4. Native Bridge.

Of the native States not exhibiting in the provincial Courts separate exhibits are shown by Patiala, Baroda, Indore, Kashmir, Bikaner, Cutch, Jodhpur, Kathiawar, Tonk, Jaipur, Khairpur, Mysore and Travancore. All of them are rich with the products of the arts and crafts practised traditionally in their territories, each possessing its individual local characteristics. They show specimens of the agricultural products from which the subsistence of a large part of their inhabitants is derived.

Baroda displays examples of its many artistic and other small industries, including pottery and its forest products, and considerable particulars are given of the provisions made for education and for the progress of co-operative societies. The Indore (Holkar) State shows only some of its agricultural products and specimens of its rich mineral deposits, but has no representation of its cotton mills or its glass, brush, tile and brick and thymol factories, nor of its iron and brass factories. The exhibit, however, is intended to attract British capital and

enterprise to protected industrial schemes that the Government has in view, particulars of which can be discussed with the officer in charge of the court, Mr. S. V. Kanungo.

Kashmir is a mountainous country, at the foot of the Himalayas, nearly as large as Great Britain, and cut up into very numerous hills and valleys, with no railroad connecting it with India, and even the carriage roads are in need of the improvement they are receiving. It has naturally, however, an abundance of potential water power, and Srinagar, its capital, is already lit by electric light from a hydro-electric installation. Apart from its fertile soil, and the varied products it bears, its many timbers, and the valuable drugs that grow in its forests, it is known to have considerable mineral deposits, specimens of some of which are exhibited. The exhibits in the Kashmir Court include examples of its resources. Though the exploration of the mineral deposits is only in an early stage it has already disclosed enormous quantities of useful minerals, some of them of great purity.

Fig. 5.

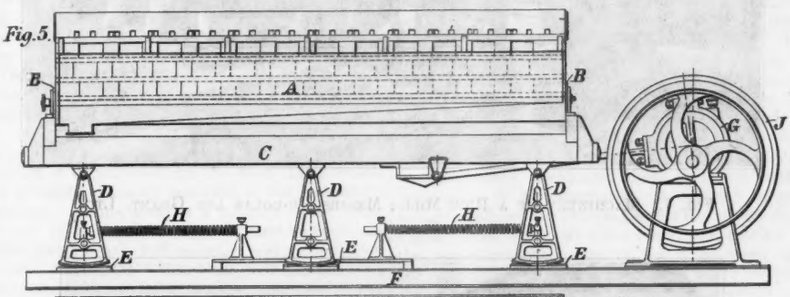
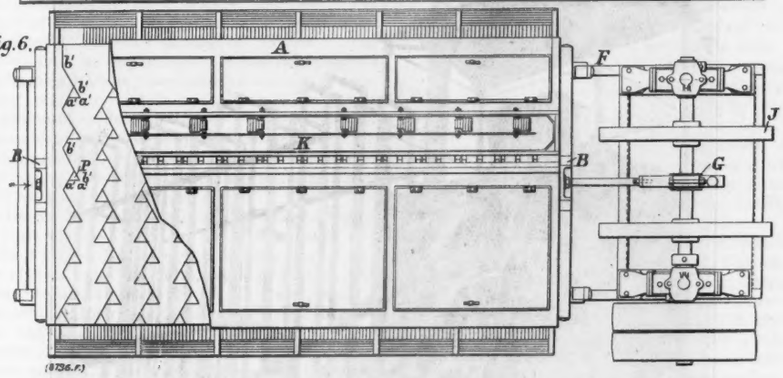


Fig. 6.



FIGS. 5 AND 6. PADDY ELIMINATING MACHINE; MESSRS. HENRY SIMON, LIMITED.

The considerable resources of the State of Bikaner, though illustrated in the exhibit, are likely to be made far more available than they are with the completion of the Sutlej Valley irrigation scheme and the extension of the railway system. In Cutch, Jodhpur, Tonk and the Kathiawar States (the last including Navanagar, the present ruler of which is illustrious to Englishmen for personal reasons) no great industrial prospects are shown. Except possibly for the marble of Jodhpur, the products are mainly pastoral and agricultural or those of cottage industries. Jaipur and Khairpur similarly show examples of their numerous traditional arts.

The exhibits of the two southern states, Mysore and Travancore, show a much higher industrial development than most. Apart from its well-known gold mines, Mysore possesses good iron deposits, from which, with its abundant timber, it makes charcoal iron, specimens of which are shown, together with the products of the destructive distillation by which the charcoal is made. The Mysore Iron Works and the Mysore Government show specimens of these, and the Workington Iron Company show the Mysore manganese ores they use, together with samples of manganese steel made from them. The Director of Geology shows specimens of chromite and other ores and minerals, for which the development of markets and industries is being sought. The important silk, cotton and wool industries show not only raw material, but a variety of finished textile products. Many industries are recognising that they need to adopt or extend the use of machinery, and the Mysore Government is advancing large sums to encourage the extended use of machinery in agriculture and industry. Agricultural machines and tractors, steam, oil and gas engines, textile machinery for small factories, oil pressing and chemical plant, and hydro-electric plant are among the machinery that is likely to be required in the near future. The purpose, indeed, of the exhibit is said to be not only to stimulate export trade in raw materials and artistic wares, but also to build up connections with manufacturers of machinery and others who can assist in developing the economic resources of the State.

Travancore, a little smaller than Wales, has rice for its largest crop, all of which it eats. Of export commercial crops, cocoanuts and tea are the most important; with the former a large production of various oil seeds may be taken, as being possibly in need of better machinery than they have. Rubber, timber, forest products and coir, with monazite, garnet sand and a variety of textiles are the chief other commercial exhibits.

Taking generally the whole of the exhibits in the Indian Pavilion, it will be seen that at the present time they represent India as interested mainly in produce and raw materials, with a gorgeous background of hand-made products, which result from the wide-spread traditional crafts of the country. India is the largest customer of the United Kingdom, as the United Kingdom is of India, and up to now Indian purchases from the United Kingdom have been steadily increasing. It should be realised, however, that for some time past there has been a strong desire pervading India, not, indeed, felt in all circles, but apparently found in all parts of the country, that India should be independent of foreign manufactures. The considerable iron and steel works, the large and increasing number of mills, and many other enterprises, for the most part not represented fully in the pavilion, show that effect is being given to the desire for increased Indian manufacture, and a question of considerable moment for British trade is how far this movement is likely to go, and to what extent it will affect the trade of this country with India.

The desire for increased Indian manufactures is accentuated by more influences than one. In some quarters, extremist politicians support it as a step towards weakening the British connection; but there seems no doubt that, however honest may be the convictions of those who are associated with this section, no important body even among politicians would be willing to "cut the painter," supposing they were offered the opportunity. Another sentiment, felt perhaps much more widely and found in some Dominions as well, is that a great nation loses dignity if it does not conduct the skilled operations of manufacture for itself, and depends for them on other nations; that, as is sometimes said, India has emerged from the state in which she should be only a hewer of wood and drawer of water for other countries. It may be questioned whether, in the long run, the sentiment will be found to stand examination. The large majority of individuals engaged in modern manufacture have the chance of showing not more but less skill than is required in the cottage arts and crafts of India, and less knowledge and judgment than is required in much agricultural, pastoral and mining work. The life of town dwellers, aggregated in factories, does not do more for a nation's stock, and for national or individual well-being, than country life; nor in the great struggle of man with nature is that population the least useful and honourable or placed to the worst advantage which extracts the resources of the earth, harnesses to its service the powers of the sun and the elements, and holds the world in fee for the indispensable products of its labours. The probable outcome in Indian opinion and practice may perhaps be gauged best by the policy of the co-operative societies, already so powerful a body, and increasing at the astonishing rate already recorded. The purpose of these institutions is so to use their resources as to yield the greatest return for the money spent in buying the appliances, and the energy absorbed in using them. The co-operative societies buy and will continue to buy what will best serve their purpose, from whatever source it comes; and to obtain and keep their trade it is necessary to offer them what will work best in the conditions in which it will be used, and costs no more than is charged by other suppliers, whether in India or elsewhere. There seems to be no question that at least for a time the practice of manufacturing will extend in India, and tend to reduce the amount of Indian imports. To what length this reduction will go, and to what extent it will be offset by the natural growth of Indian demands will depend largely on the degree in which manufacturers fit their designs to Indian needs, and are able to supply at competitive prices. What seems to be certain in the meantime is that in the immediate future India will be a large market for the sale of productive machinery of various kinds, and that many parts of the country, particularly some of the native States, are anxious to co-operate with British enterprise and capital in developing many of its valuable resources.

Three exhibits, which have special technical interest, may be described. Messrs. Henry Simon, Limited, show in operation a Paddy eliminator, an elevation of which is given in Fig. 5 and a plan in Fig. 6. The purpose of the machine is to separate the husk from the paddy or unshelled grain as completely as possible in substitution for the crude native method of separating by hand. It will be seen that the grain is fed into the machine through a feed-box at the back. The body of the machine A is carried on trunnions B mounted on a strong timber frame C, and can be set and held by clamps at an inclination to the horizontal of anything up to 10 deg. The frame itself rests on rockers D, which have teeth cast on their feet to mesh with racks E on the steel underframe F. An eccentric G gives the machine a reciprocating motion, which the rockers and racks make purely horizontal, the shock being absorbed by four helical springs H fixed on the underframe, and heavy flywheels J on the driving shaft assuring a smooth running. The grain therefore is subjected to the effect of gravity through the inclination of the body to the horizontal, and at the same time to the horizontal reciprocation imparted by the eccentric. A division plate and gates fitted to the feed-box prevent the stock from stratifying before it reaches the body of the machine. It is thus delivered in a uniform mixture into a number of compartments on the topmost of three similar floors, the flow being regulated by a slide controlled from the end of the machine, and further, by

separately set slides over the holes in the feed-box. Under the influence of the machine's motion the grain stratifies in the compartments to an extent determined by the relative densities and sizes of the grains (the smaller and denser, which are the shelled rice, tending to sink to the bottom), and to some extent also by their relative coefficients or friction. The zig-zag sides of the compartment cause relative motion between the top and bottom layers of the stratified mixture, the grain piling up against the plates *a–a* and *b–b*, with the lighter grains—the unshelled rice—at top. The grain passes through the feed holes P to the next floor, where the process is repeated, and similarly to the third floor, outlets being provided at suitable points. The separation is found to be satisfactory when the machine has a stroke of 7½ in. and is run at 105–110 revolutions per minute, the exact inclination of the floors being set at something between 4 deg. and 5 deg., according to the percentage of paddy in the feed.

Messrs. Douglas and Grant, Limited, show a model of the complete machinery of a rice mill, and Fig. 7 is a view of the machinery from which the model was made. The paddy under treatment passes over a reciprocating shaker, on which it is cleaned, and thence through an elevator into a hopper which feeds the huller, consisting of a fixed upper disc and revolving bottom disc, each covered with a composition of emery, cement and salt, and spaced according to the length of grain to be hulled. About 80 per cent. of the paddy is freed from its husk in this huller, and the mixture of husk and paddy is elevated and discharged on to a shaker, where any small "brokens" are sifted out, and the feed spread evenly across the breadth of a blowing fan over which it is next led, the husk being there blown away and the mixture of rice and paddy delivered to a further elevator. The small broken from the shaker is bagged off direct, and the husk either used for boiler firing or ground up for cattle food. The mixture of rice and paddy is discharged on to a compartment separator, the paddy being taken by a screw conveyor back to the elevator to be re-treated as before.

The rice passes into another elevator, and thence either into a bin if it is to be used without further treatment, or it is fed into a pearling cone. This appliance consists of a cast-iron tapered cone mounted on a vertical spindle and covered with emery composition, revolving inside a case covered with fine wire cloth and provided with rubber brakes. The rice, passing through the space between the cone and the case under the control of the brakes, is milled, the meal so formed passing through the wire cloth into an outer cage, from which it is discharged, and the rice passes into an elevator for discharge into a bin and thence to another cone where the milling process is repeated and finished. The rice, which now contains a certain amount of breakage and dust, passes on to a shaker and aspirator, the shaker extracting the broken and grading it, and the aspirator doing the final cleaning. For high quality rice a polishing cone is also provided, the conical part being covered with sheep skin. This type of mill represents what is used in the numerous small mills in outlying districts, and even at the large milling centres it is used in considerable numbers by the Burmese and Chinese. It does not, however, represent the design of the large mills, of capacity up to 1,000 tons in twelve hours, that Messrs. Douglas and Grant have supplied in the East.

At the rear of the Burma Pavilion a plant has been erected for treating Burma oil shale and similar material on the Crozier system, designed by Mr. R. H. Crozier, of Finsbury Court. This is a single unit using a retort 5 ft. long by 15 in. deep by 15 ft. high, which in larger scale production might be simply repeated. A view of it is seen in Fig. 8. In operation, the shale is fed through the hopper at the top of the retort, while the furnace gases (the furnace is in the side of the unit not shown in the view) pass successively through flues running round and through the retorts, being assisted by a fan producing about 1 in. vacuum. The internal flues are arranged in five tiers, each controlled separately, so that the temperatures can be regulated as desired. In practice the temperature in the bottom flue round the retort is about 600 deg. C., corresponding to 450 to 500 degrees in the centre of the shale round the inside flue. The temperature in the top of the external flue is only about 100 deg. C.

As against arrangements in which the heat from the furnace gases has to penetrate through the whole mass of the shale, this construction of flues, leading the gases not only outside the retort but through flues within the mass of the shale itself, has the advantage both of heating the shale far more rapidly and thus increasing the capacity of the plant in proportion, and of producing much smaller differences of temperature in neighbouring parts of the shale mass. Each tier, moreover, has separate offtakes just over the internal flue, so that the

INDIA AND BURMA AT THE EMPIRE EXHIBITION.

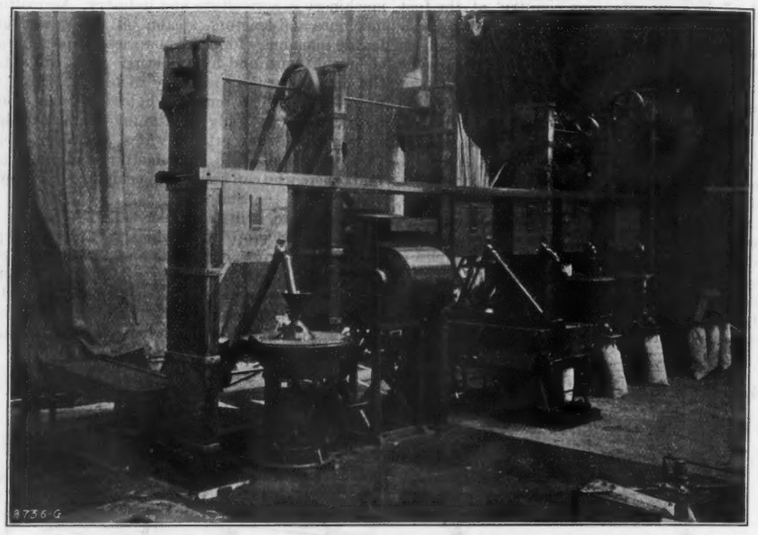


Fig. 7. Machinery of a Rice Mill; Messrs. Douglas and Grant, Ltd.

Fig. 8. Burma Oil Refining Plant.

products are drawn off almost immediately they are formed, and cracking is reduced to a minimum. Each offtake leads to a separate line of condensers, and, by counter current cascading arrangements, the light fractions first condensed are all concentrated at one end of the system and the heaviest fractions at the other end, with intermediate grades also collected separately, so reducing the work to be done in final refining. It will be observed that, provided the proportions of the width of the retort and the internal and external flues are so calculated that the shale is heated with the necessary speed and uniformity, the size of the unit retort may be increased as desired, or the output of the plant may be raised by merely multiplying units. After the operation has been started it is continued by the combustion of a portion of the gas produced in the shale. Shales both from Burma and Tasmania have been treated in the Wembley plant with results that are stated to have been highly satisfactory, a circumstance that is the more interesting because the Tasmanian shale is of a quite different type from that of Burma. It is claimed that through the greater heat efficiency and throughput assured by this system the capital cost of a unit for a given production is only about a fifth of that of the ordinary type.

Visitors from the East have remarked that nowhere in the Exhibition is the atmosphere of the exhibiting State reproduced more faithfully than in the Burma Pavilion. In the combination of design, material and workmanship the structures of which it is composed are the most characteristic and probably the most beautiful of the Exhibition buildings. Burma itself is a country about twice the size of Great Britain, with semi-independent native States nearly half as large, and a population of about 13,000,000. More than half the country, some 150,000 square miles, is forest land, and nearly three-fourths of the population are supported by agriculture. The chief product of Burma is rice, with oil next in importance. It has rich deposits of minerals, including coal and oil shale and some variety of gems, and it has also a considerable cultivation of rubber. All these resources are well represented in the Pavilion, and, in addition, the artistic products of cottage industries—wood and ivory carving, mother-of-pearl, lacquer, silver and inlaid work, embroidery, and silk.

In the description of the India Pavilion an account has been given of the Burma timbers, and the Burma Pavilion has further examples on a large scale of their varieties and many applications. In addition to the exhibit of the Burma Forest Department through their agents, Messrs. W. W. Howard Bros. and Co., the Bombay-Burma Trading Corporation, Messrs. MacGregor and Co., Messrs. Foucar and Co., Messrs. Steel Bros. and Co., and the Lower Burma Timbers, Limited, show teak and other Burma timbers, and Messrs. Hockly and Manning show paper and pulp from bamboo. A considerable number of stands exhibit agricultural produce, tobacco and cigars, and the Bur-Chin Syndicate and Mr. Ponting have notable exhibits of jade in the many tones that this beautiful mineral affects. The Burma Oil Company has a large exhibit of its products. The Burma Corporation shows minerals and metals and the Coalfields of Burma, Limited, coal and coke, the Burma Ruby Mines precious stones, and the Geological Survey of India a number of specimens and maps.

CANADA AND THE BRITISH ASSOCIATION.

(*Concluded from page* 507.)

THE next stop after Saskatoon was at Edmonton, the capital of the Province of Alberta and the seat of the provincial University. In addition to the more formal receptions and entertainments at the Parliament buildings and at the University, the citizens, with that hospitality which marked all Canadian cities, had arranged to drive the visitors to any places or objects of interest which they might wish to see, individually or collectively. Among the engineering structures visited, perhaps the most notable was the fine high-level bridge, 2,250 ft. long, carrying the Canadian Pacific Railway over the valley of the North Saskatchewan River, at a height of 152 ft. above the water level. The river itself at this point is about 600 ft. wide. The bridge is of the two-deck type, with railway and street-car tracks on the upper deck and a roadway with concrete sidewalks immediately below. The steel superstructure is carried on lofty concrete piers.

The city power plant and waterworks, situated on the river-bank practically in the centre of the city, were visited by some of the party, who were personally shown round by the superintendent, Mr. W. J. Cunningham. Of the comparatively few steam-power stations in Canada that at Edmonton is almost, if not quite, the largest, its electrical output amounting to something like 30,000,000 kw.-hours annually. The neighbourhood of Edmonton is extremely rich in lignite coal, a number of mines being within the city limits, and this, although containing about 25 per cent. of moisture, is burnt successfully on mechanical stokers without previous drying. The waterworks pumping and filtration plant, which is also under Mr. Cunningham's management, is particularly interesting to British engineers on account of the extraordinary turbidity of the raw water during several months of the year, the suspended solids being enormously greater at times than anything met with in this country. The extreme muddiness is due to the river running in flood by reason of the melting of the winter snows in the mountains. A normal flood increases the height of the water by about 20 ft., and floods of 40 ft. have been recorded. The raw water is first treated with alum in sedimentation basins and then passed through mechanical filters, and as a further precaution it is chlorinated. A scheme is now being considered for bringing water to the city from Pigeon Lake, about 80 miles away, but, in view of the bacteriological purity of the river water and the ease and certainty with which water supplies can now be safeguarded the expense would not seem to be justified, particularly as the lake water would also need chlorination in order to be safe.

The rigour of the climate in Western Canada and the nature of the great prairie rivers like the North and South Saskatchewan, the Belly River and others, raise many interesting problems in connection with water-supply. For about six months of each year these rivers are covered with 2 ft. or more of ice, and during the summer months they are unconscionably dirty. Ordinary distribution mains have to be laid about 8 ft. deep to be safely below the first line, and the silt in suspension in the summer water can cause great difficulties with intakes, pumps, &c., not to mention filtering plant. The coldness of the water in the winter is excellent for condensing purposes, and at Edmonton the condensing water from the power plant is taken from and returned to the sedimentation basin during the winter months. This raises the temperature of the water, on an average, by 20 deg. F., and thus enables the filter plant to be operated all the winter without freezing. It probably also does much to save frozen house services throughout the city.

Edmonton is one of the fortunate cities with a natural gas supply. The gas field is quite distinct from the famous one south of the Province supplying Lethbridge and Calgary. Edmonton gets its gas from a field at Viking, 70 miles from the City, located in 1913 by the enterprise of some of the public-spirited citizens. The first wells put down struck gas at about 2,300 ft., and the pressure in the well rose to about 600 lb. per square inch when shut off. It is piped to Edmonton at a pressure of 200 lb. per square inch, and reduced, of course, for the distribution system. The gas is practically pure Methane (CH_4), with a calorific value of about 1,000 B.Th.U. per cubic foot. It is retailed at 45 cents per 1,000 cub. ft., or about 2½*d.* per therm. It is not, of course, used for lighting, but for cooking and heating. Even in Medicine Hat, electric light is universal, the gas, which is sold at only a few cents per thousand feet, being used to fire steam boilers at the Power Plant. At Calgary, in the steam power plant which serves as a standby to the hydro-electric plant, several boilers are arranged for gas firing. The cleanliness and convenience of this method of firing and the absence of all coal dust and ashes make a great change in the aspect of a boiler-house.

The wealth of Canada in timber was well brought home to the party by the thousands of miles of forest passed through, in Quebec, Ontario and British Columbia, but no one could help deploring the terrible waste caused by forest fires. The dead trees and the blackened stumps everywhere looked sad enough even seen through the summer foliage of the undergrowth, but only those who know the appearance of burnt forest when the snow is on the ground fully realise what sense of desolation a landscape can convey. It is said, with what truth we do not know, that more timber is burnt annually in Canada than is cut. The Government however, are fully alive to the situation, and, in addition to posting up earnest appeals to all campers, trappers and others to see that their fires are properly put out, they maintain an army of 3,000 fire-fighters to preserve the forests. There are numbers of hydroplanes on the Ontario lakes, and fire rangers are in telephonic communication with them. On the sight of any suspicious smoke, a hydroplane is notified and told to investigate. The observer reports by wireless or otherwise, and if necessary fire fighters are carried to the spot by other aeroplanes, together with pumps, axes, chemical extinguishers, &c.

As is well known the largest timber in Canada is to be found on the Pacific Coast, and the magnificent trees in Stanley Park, a bit of primæval forest in Vancouver, were specially striking. Thousands of giant cedars and Douglas firs, many of them hundreds of feet high and without a branch until near the top, showed how timber could grow under suitable conditions. Some of the party visited the Fraser lumber mills at New Westminster and saw how the largest logs were converted into sawn lumber. The way the logs were hauled out of the water by an inclined conveyor, pushed from it to a travelling platform and squared by successive passes by a bandsaw which had teeth on both sides and so cut on each traverse, was a revelation in the speed of handling heavy stuff. The whole of the power was derived from burning sawdust under boilers, and even then 160 tons of wood refuse per day were destroyed by burning in large kilns. It would seem that some use should be found for this refuse wood, either by distilling it or otherwise, but apparently it is more economisal to burn it.

The wood-pulp and paper-making industry is one of very great importance to Canada, and the visitors were enabled to get an insight into the processes of making newsprint by a visit to the Abitibi Power and Paper Company's works at Iroquois Falls, Northern Ontario. Here about 25,000 h.p. is developed and mostly used in the mill. Owing to the remoteness of the place, the company have built a garden city, with schools and churches, for the workpeople, of whom 1,400 are employed in the mill and some 2,000 in the woods during the winter. A golf course, steam laundry, dairy, athletic grounds, &c., are also provided by the company. The number of aerials for broadcast reception which were to be seen showed how greatly this kind of entertainment is appreciated in really isolated small communities. In the mill the logs are cut into short lengths and then "barked" by being tumbled about in rotating cylinders. They pass continuously through the cylinders, and any still retaining patches of bark are rejected by an attendant who pushes them into a water channel which floats them back to the cylinders. Those to be used for sulphite pulp are put through machines which tear them into chips which are subsequently digested in the sulphite tanks. Those destined for the cheaper mechanical pulp are ground up between great grindstones against which they are forced sideways by hydraulic pressure. They are flooded with water meanwhile, as a great amount of heat is developed. There are 51 of these machines, each capable of grinding 10 tons of wood per day.

The newsprint mill, said to be the largest on the Continent, has seven paper-making machines, two of them made by Messrs. Charles Walmsley and Co., Ltd., Bury, being the largest in the world. Each makes a sheet of paper 18 ft. 5 in. wide at the rate of 700 ft. per minute. The mill has a daily capacity of 500 tons of newsprint, 30 tons of wrapper paper, 510 tons of mechanical pulp and 140 tons of sulphite pulp. The company uses 200,000 cords of pulp-wood

COFFEE-PREPARING MACHINERY AT THE BRITISH EMPIRE EXHIBITION.

CONSTRUCTED BY MESSRS. E. H. BENTALL AND CO., LIMITED, ENGINEERS, MALDON.

(*For Description, see opposite Page.*)

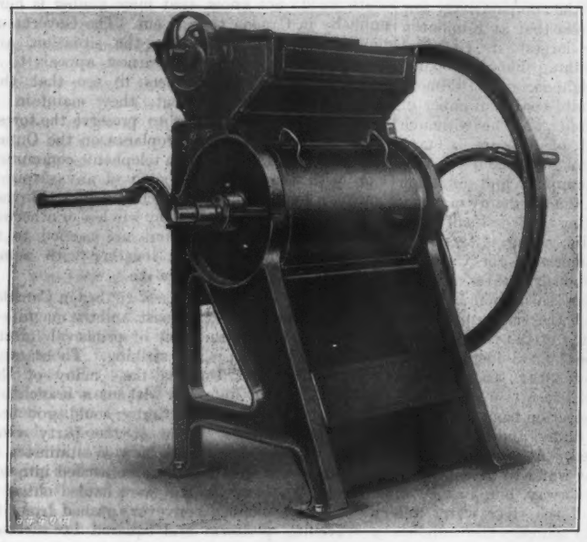


Fig. 1. Cylinder Pulping Machine.

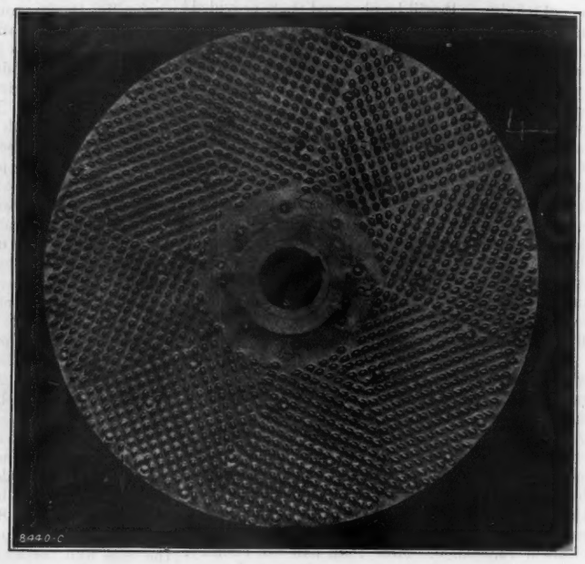


Fig. 2. Pulping Disc.

per year, and cuts down, on an average, 60 acres of forest a day. A nursery yields 3,000,000 seedlings annually and re-afforestation has been started this year. To assist in the protection of the forest, the company employs fire rangers of its own who have an observation tower and portable pumping and water tank equipment. The magnitude of the company's operations will be understood from the fact that on an average 70 of the large Canadian freight cars enter and leave the yards a day, and in the same time 114,000,000 square feet of paper can be made.

Another Canadian industry, the growth of which is hardly realised perhaps by engineers in this country is that of metal mining. Iron, unfortunately, is not yet available in any large quantities, but gold, copper, lead, silver, nickel and many other metals are produced in abundance. The party were given an opportunity of going down the great Hollinger gold mine, which produces and mills about 5,000 tons of ore per day, and produced 10,600,000 dollars' worth of gold last year. The Lake Shore gold mine at Kirkland lake also in Northern Ontario, was also visited. When in British Columbia the party visited the Britannia copper mine and concentrating plant at Howe Sound. At Cobalt they viewed a silver mine, and at Sudbury, on the return journey, stops were made to inspect the copper-nickel smelting works. The copper production of Canada last year was nearly 43,000,000 lb., nickel was produced to the extent of 17,600,000 lb. and over 94,000,000 lb. of lead were mined.

Travelling, as they did, over more than six thousand miles of the Canadian Railways, the members of the Association had ample opportunities for noticing the features of construction and operation in which Canadian railway practice differs most markedly from our own. They travelled in two special trains with a 20-minutes interval between, and lived on the trains continuously from Toronto to Vancouver and back, the double journey, with its various breaks, lasting from August 17 to September 4. Each train was about 1,100 ft. in length and comprised 13 cars varying in weight from 50 to 80 short tons, the heaviest cars being of all steel construction. The cost of each train was said to be 700,000 dols., or, say, 140,000*l.* at the normal rate of exchange. The length of the trains was such that the front part frequently appeared to be at right angles to the rear when taking some of

Fig. 3. Disc Pulping Machine.

the curves in the Rockies, and at other times the train was S-shaped. Generally speaking, the comfort of travelling was all that could be desired, but starting from rest appeared always to be accompanied by one or more violent concussions of a nature quite unknown on British railways. These were, possibly, due to some peculiarity of the central-coupling system, in which the drawbars have to act also as buffer-bars, but however they were caused, some mitigation of them would seem desirable.

The universal use of flat-bottomed rails spiked directly to the sleepers or "ties" was a further noticeable difference from British practice, but more striking perhaps than anything was the magnitude of the freight cars. The little eight and ten-ton trucks, beyond which British railway enterprise seems unable to go, are replaced by vehicles holding an average of 30 or 40 tons of goods, fitted with central couplings, automatic brakes, and, of course, running on bogies. In comparison with these the little British truck seemed almost amusing as a means of economically handling freight, and especially bulk goods, such as coal. It is true that Canadian railways are not so limited by loading gauge restrictions as our own, but the fact that we can run dining saloons and sleeping-cars of reasonable size, suggests that the limit of development has hardly been reached with respect to coal wagons.

The route chosen for the trip did not involve a passage either over the famous Lethbridge viaduct, a steel structure, more than a mile long, carrying the Canadian Pacific Railway over the Belly river at a height of 314 ft., or over the high-level railway bridge at Edmonton, although the latter was traversed by road when the City was visited. There was, however, plenty of remarkable railway constructional work to be seen, including the Connaught tunnel, exactly five miles long, the longest in America. This pierces Mount Macdonald, in the Selkirks, and takes the place of the long loop which earlier travellers will remember, by which the railway climbed over the Rogers Pass, 552 ft. above its present level. The old loop line had to be protected in winter by four miles of snowsheds, as the average snowfall in this neighbourhood is 34 ft. 6 in. annually. The tunnel which is double-tracked, is 29 ft. wide, with a clearance of 21 ft. 6 in. over the rails. Its construction not only saved the 552-ft. climb mentioned but eliminated curves amounting to seven complete circles. When the party passed through, a good deal of concrete lining work was in progress. The train emerges from the tunnel at a height of about 1,000 ft. above the Beaver River, which will give some idea of the indescribable magnificence of the scenery. Nearly 100 miles further east, the railway crosses the "Great Divide" at an altitude of 5,338 ft., a stream at this point being diverted by a Y-shaped concrete channel, so that half the waters were turned westwards into the Pacific and half eastwards into the Atlantic. To reach the level of the Divide, the railway has to climb 1,145 ft. in the seven and a-half miles between Field and Hector, and the original line had a maximum gradient of 4·5 per cent. To ease this, the famous "spiral tunnels" were constructed, and the party passed through them. The line now first enters Mount

COFFEE-PREPARING MACHINERY; EMPIRE EXHIBITION.

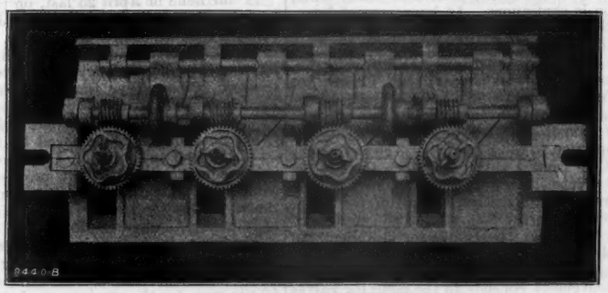


Fig. 4. Breast for Pulping Machine.

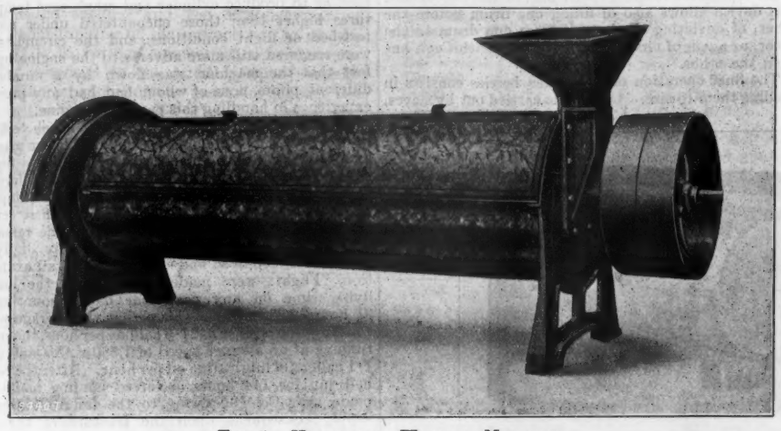


Fig. 5. Horizontal Washing Machine.

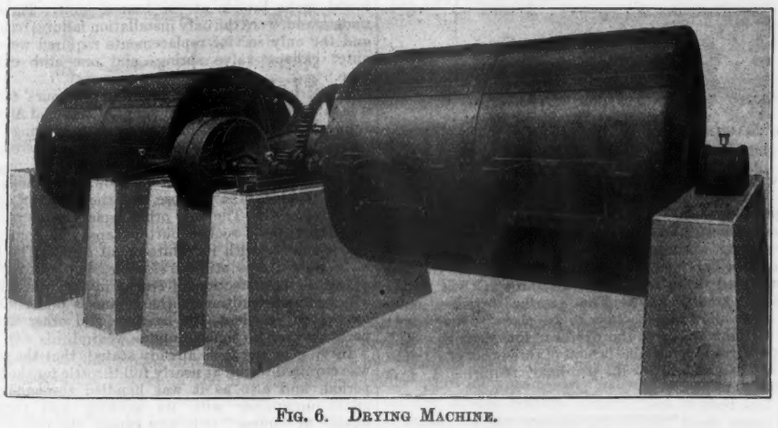


Fig. 6. Drying Machine.

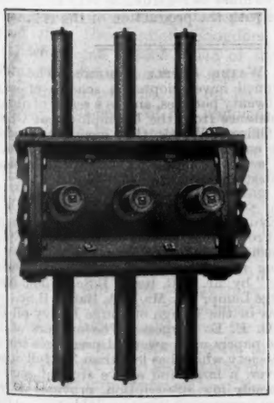


Fig. 7. Radial Tubes of Drying Machine.

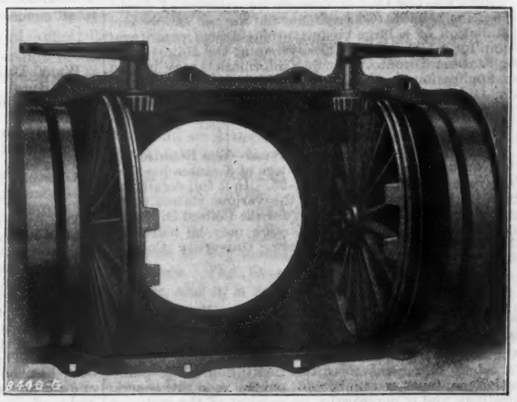


Fig. 8. Deflector Valve of Drying Machine.

Ogden and passes through a circular tunnel, 2,922 ft. long, emerging almost over its entrance, but 50 ft. higher. It then crosses itself and enters Cathedral Mountain, passing through another circular tunnel 3,255 ft. long, and emerging a further 54 ft. above its entrance. The tunnels make a complete "figure of 8," and have the effect of reducing the maximum gradient to 2·2 per cent. Over this section the trains were run double-headed, a couple of very powerful oil-burning mountain locomotives being attached to each train. The trains were stopped in the mountains during the night, so that the whole of the magnificent scenery could be seen by daylight, a little detail typical of the thoughtfulness displayed both by the Canadian National and the Canadian Pacific Railways for the pleasure of the party throughout the entire journey.

COFFEE-PREPARING MACHINERY.

Messrs. E. H. Bentall and Co., Limited, Heybridge Works, Maldon, Essex, exhibit in the Palace of Engineering of the British Empire Exhibition a series of the machines which they build for coffee plantations, for pulping, washing, drying, polishing and grading coffee berries, all processes involved in the preparation of coffee for the export market. The display includes washers, peelers, pulpers and their components, and several of these machines are illustrated in Figs. 1 to 9 on this and the opposite pages and on page 542. The machines are utilised in the preparation of the coffee in the country in which it is grown, and they leave it in the condition in which it arrives on the European market. Messrs. Bentall export large numbers of the machines to South America and other coffee-growing countries.

The coffee berry, with which everyone is familiar, is the seed or stone of the coffee "cherry," which is about the same size and of much the same appearance as a cherry proper. Each coffee "cherry" contains two seeds. The first operation to which the coffee has to be subjected when it arrives at the mill from the fields is the removal of the pulp or flesh. This operation is carried out on a pulper, which consists essentially of a disc or cylinder provided with a copper surface covered with a series of projections. Cylinder and disc machines are illustrated in Figs. 1 and 3 respectively, while one of the discs of a disc machine is illustrated separately in Fig. 2. This illustration will give a better idea of the surface by which the cherries are treated than would a long verbal description. The copper plates are, of course, formed by dies, and the actual shape of the projections varies with the class of coffee being dealt with. In some cases the surface of the projections is rough, while in others the metal is broken through at the top of the projection, leaving a rough surface. A water supply passes through the pulper when it is in operation and washes away the loosened pulp, leaving the berries clean. The pulp is to a large extent a waste product, and one with which we have no further concern in this description.

Messrs. Bentall have introduced a new and efficient feed regulator for pulpers which overcomes a difficulty that has long been experienced with machines of this type. By the feeder the supply of berries to the pulping disc or cylinder is accurately regulated, and in addition to improved feeding they have introduced a new type of outlet valve or breast with simultaneous and independent regulation of the doors. The independent regulation enables the doors to be adjusted for wear, whilst the simultaneous regulation gives quick adjustment for varying grades of berries. Regulation, which can be made to very fine limits, is simple and positive. Fig. 1 illustrates the "Essex" cylinder pulper, fitted with the Bentall patent breast. This hand machine is manufactured in two sizes, capable of dealing with 2,400 and 1,200 lb. of ripe berries per hour. Fig. 3 shows one of the firm's disc pulpers. The use of this type of pulper has greatly developed of late years, a number of plantations preferring it to the cylinder machine, although the work done in both is very similar. According to the advocates of the disc machine, the work turned out is cleaner, requires less water, and since there are, according to the size of the machine, two, four, six or eight pulping surfaces, should one surface become inefficient the others would still come into play. These machines are built with one, two, three or four discs, and the disc is covered on either side by a circular copper plate having many projections as shown in Fig. 2. The pulping action takes place by the friction of the projections upon the berries combined with the action of oblique, adjustable bars. All sizes, except the one having only one disc, are provided with an improved feeder cylinder in the hopper, which ensures equal work for each disc. The coffee as it leaves the machines is perfectly smooth and clean,

the breast being adjusted so that the berry is not released until it is properly freed from pulp. The largest machine, which has four discs, has a capacity of 9,600 lb. of ripe berries per hour. Messrs. Bentall manufacture discs, the projections on which vary to suit the various grades of coffee grown in different parts of the world.

One of the Bentall patent breast pieces for coffee pulpers is illustrated in Fig. 4. The main feature of this is the simultaneous and positive regulation of the water jets and outlet doors. As explained above, the doors may be regulated independently or together by means of the gearing shown. In the Bentall breast piece the gates are hinged; in the former types the gates formed an integral part of the breast piece and were liable to break and to render the whole device unserviceable. No part of the new arrangement is under tension stress, and this component of the cylinder coffee pulping machine works smoothly and accurately.

The coffee berries pass from the pulper to a fermentation tank before passing forward for further treatment. They normally remain in the tank for some time. Such tanks naturally cannot well be shown at the Exhibition but Messrs. Bentall show sluices for the tanks. When two sluices are used, one for the water outflow and the other for the coffee berry discharge, the operation is as follows: The two sluices are closed when the pulper is started. As soon as the fermentation tank is filled to the required capacity, since there is an excess of water in the tank, the lower sluice is opened until the water remaining is just sufficient for fermentation. Once the coffee has fermented, the tank is filled afresh with water, the two sluices remaining closed. The added water serves to remove the viscous and frothy matter, the water carrying this being drawn off by opening the lower sluice. This sluice is then closed again, and the tank is again filled with water. When this is done the upper sluice is opened and the water carries the berries to the washing tank, or washing machine, as the case may be.

In Fig. 5 is shown the 8-ft. Bentall horizontal washing machine. The characteristic feature of this machine is that it is continuous in its action. It consists of a cylinder in which revolves an axle provided with radial arms. These beat the berries in the course of the washing action and remove the gummy matter which adhered to them following upon the fermentation process. On the top of the cylindrical drum, as will be seen in the illustration, are two inspection doors. The drum is 24 in. in diameter while the axle revolves at a speed of 180 r.p.m., and can be driven by any convenient source of power. The machine has an output of 1,500 lb. of washed berries per hour. The water can be regulated as well as the quantity of berries discharged.

When the coffee berries leave the washer they are taken to a dryer. Machines of this class are rather bulky and for that reason are not actually shown by Messrs. Bentall as part of their Wembley display. We have, however, included in Figs. 6 to 8 some illustrations of the firm's driers in order to make our account of their coffee-preparing machinery reasonably complete. The dryer consists of a cylindrical drum built up of sheet-steel, revolving on a hollow axle on which are placed a number of perforated radial tubes. The drum is divided into four equal and separate compartments. Each compartment is provided with a number of mixers which exert a regular beating action on the coffee as the drum revolves on its axle. The coffee is placed in and removed from the drum through doors, two of which are seen in Fig. 6. Hot air can be supplied to the drum from any source. The hot air enters at one end of the hollow axle, and is distributed to the four separate compartments by the perforated radial tubes, and its action is continuous. An improvement introduced by Messrs. Bentall consists in building the dryer in two lengths; instead of giving the drum a length of, say, 16 ft., they build two drums each 8 ft. in length, the arrangement being that shown in Fig. 6. The hot air enters at one end of each 8-ft. drum. The new construction enables the coffee planter to dry either a comparatively small quantity, or a full quantity, at a cost in proportion to the bulk dried. The machine is provided with a central valve, by which the hot air can be diverted into either cylinder, or supplied to both as the case may be. Formerly, the perforated radial tubes were screwed in the hollow axle, and were difficult, if not impossible, to remove for cleaning. In Messrs. Bentall's dryer they are fitted as shown in Fig. 7, and can easily be removed when required. Another improvement consists in the deflector valves (Fig. 8), which they have introduced in the double drum dryers, for running either one, or the two drums. The device allows also of filling one drum before the other, of deviating the hot air from one drum to the other, or again of circulating more hot air through one than the other.

The final operation on the coffee berries consists in grading them to size. Grading is carried out by sieves, each passing berries up to some predetermined size, so that by passing from one sieve to another a separation into classes may be obtained. Various arrangements are used, some with reciprocating sieves, but a simple and effective arrangement is that shown in Fig. 9. The berries travel along the rotating perforated drum and pass each through their appropriately-graded sieve. The gearing can be made so as to allow the machine to be placed parallel with or at right angles to the overhead line shafting. This type of grading machine is built of three sizes of 1,100 lb. 1,600 lb., and 2,200 lb. per hour, requiring $\frac{1}{3}$, $\frac{1}{2}$ or $\frac{1}{2}$ b.h.p. respectively.

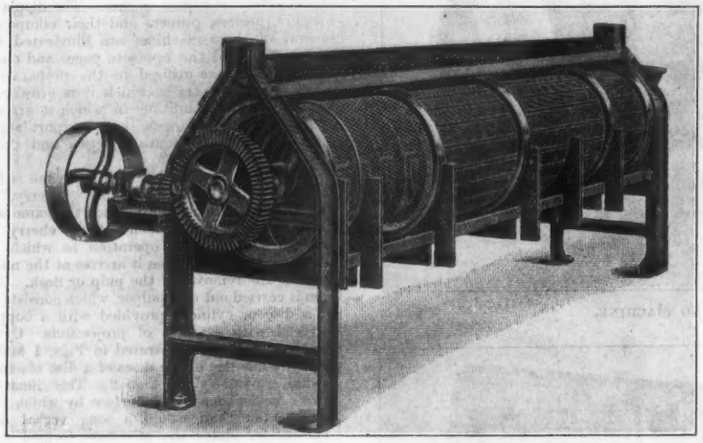


Fig. 9. Grading Machine.

THE BRISTOL "JUPITER" AERO ENGINE IN COMMERCIAL SERVICE.

In our issue of April 25 last, on page 551, we illustrated and described the Bristol "Jupiter" 400-h.p. static-radial, air-cooled aero engine, mentioning some of the tests carried out on this engine to demonstrate its reliability and efficiency. These tests have included the two 50-hour type tests of both the British and French Air Ministries, as well as separate endurance tests of 150 hours each in both of these countries. Other notable results achieved by the engine, both on the ground and in flight, have also been referred to in our columns, and it is now proposed to add to these some particulars of the results recently obtained with the engine in service on the Continental air routes of Imperial Airways, Limited.

The engine in question was mounted in a "Bristol" freight-carrying aeroplane weighing 6,200 lb. when loaded, which necessitated a throttle opening of over 90 per cent. for the attainment of the normal cruising speed. The installation scheme, we understand, was such as to produce cylinder and crank-case temperatures higher than those encountered under normal test-bed or flight conditions, and the circumstances were rendered still more adverse to the engine by the fact that the machine was flown by a number of different pilots, none of whom had had any previous experience in handling this particular engine.

After the usual three hours' official bench test had been carried out, the engine was installed in the machine and 17 hours' flying time was occupied in test flights, climbs, airworthiness-certificate tests, &c., before the machine was taken over for service by Imperial Airways, Limited, on July 19 last. The first service flight was made on July 22, and the engine remained in use until it had completed 150 hours of flying, when it was removed and stripped for detail examination. Flights were made on 21 days, the longest flying time on any particular day amounting to 9½ hours. Throughout this period, the average petrol consumption is given as 24·8 gallons per hour, the engine running at an average speed of 1,580 r.p.m. and using 1·1 gallons of lubricating oil per hour. After the engine had run for 144 hours, a forced landing had to be made near Cologne owing to the failure of the oil supply consequent upon the fracture of the pipe connection to the oil-pressure gauge. On another occasion the oil pipe from the scavenge pump was found to be broken at the brazed joint. These, we understand, were the only installation failures recorded, and the only service replacements required were two outer exhaust-valve springs and one stub exhaust pipe.

The stripping of the engine after 150 hours' running was carried out in the repair shops of Imperial Airways, Limited, the dismantling process occupying three mechanics for 3 hours; the subsequent re-assembling of the engine occupied 19 hours. In removing the piston rings several were broken, owing to the lack of proper tackle for the purpose, and these had, of course, to be replaced. The only other replacements required were three inlet-rocker buttons and one connecting rod, complete with its white-metal bush. The bush, it is stated, was still serviceable, but was replaced owing to the detection of cracks in the white metal. The general condition of the engine is understood to have been excellent, the bearings and other working parts showing no signs of undue wear.

In view of the fact, already stated, that the engine was required to run at nearly full throttle for the whole period, and also as it was handled throughout by pilots unfamiliar with its working and therefore unable to "nurse" it to any extent, the performance as recorded above must be regarded as very satisfactory to all concerned with the production of the engine.

Tender.—The City of Toronto Department of Works is inviting tenders (Contract No. 58) for the supply and installation of a large steam turbine-driven centrifugal pump for a high-pressure fire system at the Main Pumping Station, Toronto. Further information may be had on application to the Department of Overseas Trade, 35, Old Queen-street, London, S.W.1, on quoting reference A.X. 1335.

University College of Swansea.—The Engineering Prospectus of the University College of Swansea has now been issued for the session 1924–25. In it full details are given of the work covered in the various classes to be attended by students qualifying for the College Diplomas in Engineering, and all information may be had from the Registrar, Mr. Edwin Drew, University College, Singleton Park, Swansea.

The Institution of Railway Signal Engineers.—The Proceedings of the Institution of Railway Signal Engineers (Incorporated) for the period February to August, 1924, have now been published, at a price of 7*s.* 6*d.* to non-members of the Institution. The publication contains a number of papers read at general meetings, and is noteworthy on account of the inclusion of a number of plates on Indian signalling practice accompanying a paper on the subject by Mr. A. C. Rose.

West Dean Water Supply Scheme.—The West Dean Rural Council have adopted a scheme of water supply for some twenty parishes, and as a result of obtaining financial assistance from the Unemployment Grants Committee and Office of Woods, they have been enabled to instruct their engineers, W. H. Radford and Son, of Nottingham, to send the detailed plans to the Ministry of Health. The estimated cost is 45,000*l.*

The Rugby Engineering Society.—The seventeenth volume of the Proceedings of this useful Society have now been published at the price to non-members of 10*s.* 6*d.* Among its contents are papers on "Steam Turbine Blading," by Mr. J. C. Read, B.Sc., "The Neon Cathode Discharge Lamp," by Mr. L. A. Barry, B.Sc., and "Some Problems in the Design of Large Heavy-oil Engines," by Mr. G. E. E. Burgess. The authors of the first two of these papers were awarded premiums by the Council. The Society which has less than 300 full members, has, however, a large and active student section, and for an extremely low subscription, provides library and reading-room accommodation, available to 10.0 p.m. every night. The Hon. Sec. of the Society is Mr. G. H. Paulin, A.M.I.Mech.E., Willans Works, Rugby.

THE TWIN-SCREW GEARED TURBINE ORIENT LINER "ORAMA."

TRANSPORT by sea is as important to the British Empire as the carriage of goods and passengers by rail or road, within their territories, is to self-contained countries. Indeed, it may with truth be said that to an empire spread over the entire face of the globe, sea transport is a form of internal communication. It is for this reason quite natural that the position of supremacy in shipbuilding and of ascendancy in the utilisation of the products of the naval architect and marine engineer, in the distribution of goods and passengers, is in British hands. Efficient transport and communication are the means by which the ties between the component parts of any country or empire are strengthened. When they are provided, the immediate effects are increased trading and the establishment of better understanding of the outlook of the people, which leads to further commercial developments. The first essential to the building up of empire trade is the provision of the means of placing the goods in the overseas markets at cheap rates and with despatch. Passenger facilities must also be increased in order that a complete understanding of the requirements of individual markets may be obtained at first hand without great loss of time. While railway transport in many of the Crown Colonies is not all that is desirable, the same cannot be said of the provisions made for carrying goods and passengers across the seas. Shipowners have kept abreast of the requirements, and whenever they asked for improvements in design or the incorporation of new developments, made possible by the progress of engineering and naval architecture, the shipbuilders have always been able to provide constructions suited to their demands.

At no time in the history of the British Empire has it been more necessary to study transport problems, whether relating to land or sea, than is the case at present. The Dominions and Crown Colonies produce almost everything of importance that is imported into the United Kingdom, and offer markets which can absorb much of the output of the Home factories. This trade must be encouraged by every means possible, for on its development depends the well-being of the population of Great Britain and their kinsmen overseas. Australia affords a good example of a part of the Empire having almost unlimited natural resources. She holds at present the position of being the second best market for British goods, and the United Kingdom is the greatest importer of her produce. There are, however, hopes for even greater results, and there is every indication that in a few years' time Australia will hold the premier position in British imports against the competition of the World. In the last complete year for which figures are available, the Australian exports to the United Kingdom amounted to no less than 58 million pounds in value, and her imports from Great Britain reached 53 million pounds. Trade between Australia and other parts of the Empire added 18 millions to the exports and 13 million pounds to the imports of the Commonwealth. This market and that of New Zealand must be regarded, therefore, as of vital importance in any consideration of British overseas trade. To those who have provided facilities for travel to Australia and also for the conveyance of goods, must be given great credit in the establishment of closer relationships between the United Kingdom and the Commonwealth. The Orient Steam Navigation Company, Limited, are making every effort that is possible to maintain and improve the passenger and mail service, and we illustrate on Plates LVI and LVII the profile and deck plans of the recently constructed vessel Orama, which, after her speed and other trials are completed, will be put on the Australian service. This vessel was constructed by Messrs. Vickers Limited, at their Barrow-in-Furness shipyard.

The leading dimensions and other particulars of the Orama are :—

Length (overall)	658 ft.
Length (between perpendiculars) ...	630 ft.
Breadth...	75 ft.
Depth to "E" deck	47 ft.
Gross tonnage	20,000 tons
Deadweight	10,230 tons
Draught	29 ft. 7 in.
Speed	20 knots
Shaft horse-power	19,500

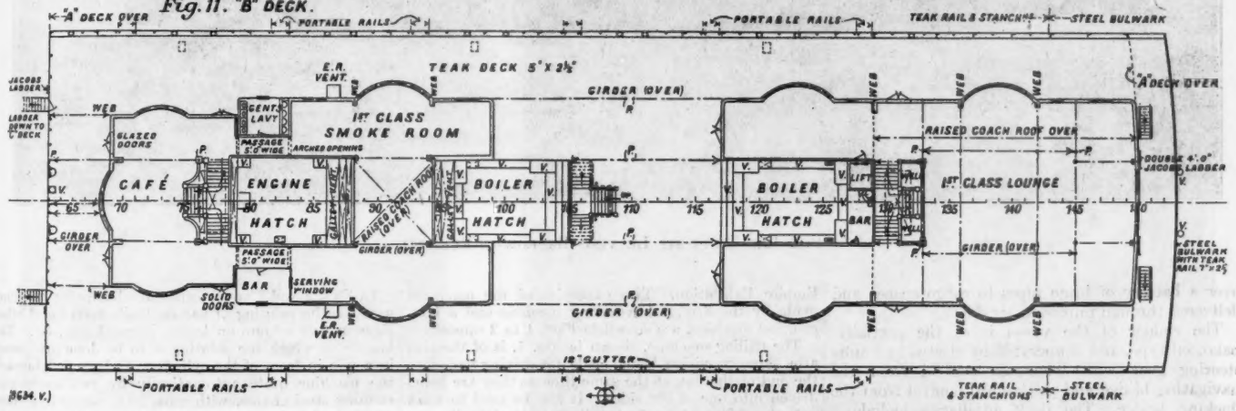
The vessel was built to be classed 100 A.1. at Lloyds' under the 1922/1923 rules, and also meets the requirements of the British Board of Trade for passenger ships. From the profile shown in Fig. 1 Plate LVI, the graceful appearance of the vessel may be appreciated. She has a straight stem and cruiser stern, which with the arrangement of decks, the two funnels and the two masts make the Orama a handsome addition to the British mercantile marine. The sub-division is effected by the fitting of twelve watertight bulkheads, which, where necessary, are provided with doors operated both by hand and by hydraulic power. Operation of these doors by hydraulic gear may be performed from the bridge quite instantaneously in case of emergency. A cellular double bottom construction is used and is arranged for the storage of oil fuel, fresh water and water ballast. There are eight decks, including the boat deck, the arrangements of which are clearly shown in the plans, Figs. 2 to 5 on Plate LVI, in Figs. 6 to 9 on Plate LVII, and in Fig. 11 on this page.

The Captain and other executive officers are accommodated in the large deck house at the forward end of A deck, from which the navigating bridge above may be reached. On this deck 20 lifeboats, 2 sea boats and 2 motor boats are carried in MacLachlan davits. Other boats forward and aft, which are dealt with by MacLachlan's, Stewarts' and Welin's davits, bring up the total complement of lifeboats to 37, including two powerful 30-foot motor boats. The Orama carries 592 first-class passengers, and it is claimed for her and her sister ships, the Oronsay, being built by Messrs. John Brown and Company, Limited, Clydebank, and the Otranto, at present under construction by Messrs. Vickers Limited, at Barrow-in-Furness, that they will have a larger number of single berth cabins than any ship afloat.

On deck B, Fig. 11, on this page, a spacious lounge is provided forward and the first-class smoking room and café are situated aft. The decoration and furnishing of these and the other public rooms as well as the cabins, we hope to describe, and to indicate the provisions made for the comfort of passengers, in a later article. Arrangement is made for the conversion of part of this deck into a ballroom by the use of special screens. From the B deck lifts descend for the conveyance of passengers to the other decks where the public rooms and cabins are situated. At the forward end of the C deck, see Fig. 4, Plate LVI, a reading and writing room is provided, which is octagonal in plan. Below this on the D deck there is a special promenade for children and further first-class cabin accommodation. It will be observed from the plan, Fig. 5, that the cabins are arranged in three tiers, the two inner ones being provided with an extension, so that each cabin has a portlight. There is a special suite as well as 13 cabins-de-luxe on this deck, with each of which is provided a private bathroom. A large deck house aft is arranged as a general and isolation hospital. A similar three-tier arrangement of cabins to that referred to in connection with deck D is also provided on decks E and F, Fig. 6 and 7, Plate LVII. Here there are promenades provided for the third-class passengers and dining saloons for both classes of passengers, as well as the third-class lounge and smoking room. Beside the first-class dining saloon there is a foyer, and the decoration of both of these is one of the features of the vessel. The galley is situated between the two dining saloons, a position ensuring the minimum of work in obtaining good service. The spaciousness of the kitchen accommodation and the arrangement of its components, stores, bakeries, larders and sculleries, for easy working is apparent from the plan, Fig. 7. The galley ranges are oil fired, but advantage has been taken of electric power for the auxiliary cooking appliances and machines. Particular attention has been paid to the comfort of the 1,244 third-class passengers which the vessel carries. They are accommodated on the G and H decks, Figs. 8 and 9, in 2, 4 and 6 berth cabins.

The ship is lighted electrically throughout, power being obtained from three turbo-generator sets each of 400 kw. capacity and an emergency set of 36 kw. A complete system of steam heating is provided for all the passageways, and the arrangements have been carried out so that heat is radiated to the individual cabins. Certain of the first-class cabins are provided with electric radiators, and steam-heated radiators serve for the maintenance of the desired temperatures in the public rooms. A complete piping system conveys fresh water, hot and cold, and salt water, hot and cold, to the bathrooms and lavatory accommodation throughout the vessel. There is an extensive refrigerating system making use of carbon dioxide and operated by three electrically-driven machines, which, with the evaporators and electrically-driven brine pumps, are placed in a special compartment on the tank top forward of the boiler-room, Fig. 10. The three holds forward of the refrigerating engine room are insulated for the carriage of frozen cargo, as also are the second and third lower 'tween-decks. Special arrangements are made in the second and third holds and the second and third 'tween-decks for the carriage of fruit and dairy produce, cooling being provided by means of air, which is blown

Fig. 11. "B" DECK.



THE TWIN-SCREW GEARED-TURBINE ORIENT LINER "ORAMA."

CONSTRUCTED BY MESSRS. VICKERS LIMITED, ENGINEERS AND SHIPBUILDERS, BARROW-IN-FURNESS.

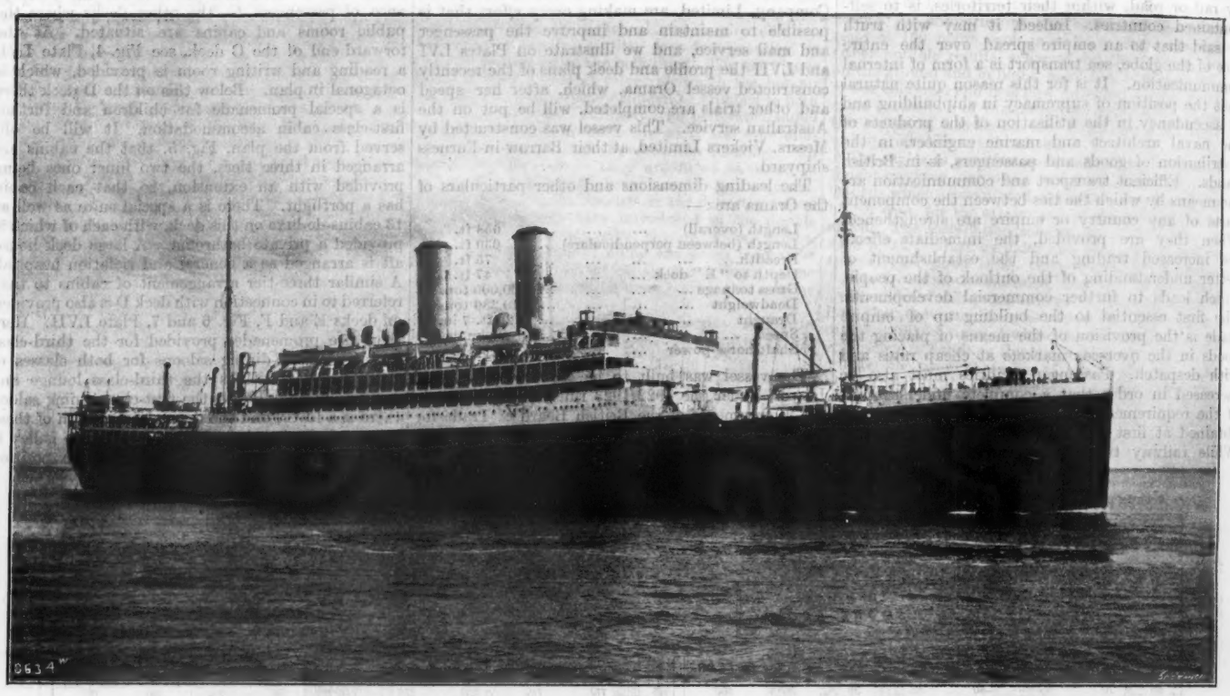


Fig. 12. The Ship Leaving Barrow-in-Furness.

over a battery of brine pipes to cargo spaces and delivered through improved air ducts.

The rudder of the vessel is of the partially-balanced type, and is operated by electro-hydraulic steering gear with telemotor control from the navigating bridge and mechanical control from the docking bridge. The deck auxiliaries include a large steam windlass of high power with extended ends for warping, two steam capstans forward and two electric warping capstans aft. There are ten electro-hydraulic and six electrically-driven cargo winches, while six boat-hoisting winches are provided for working the MacLachlan davits and one for handling the emergency boats.

The Orama left Barrow-in-Furness on Sunday last for Belfast, where she arrived in the evening and was successfully docked by noon on Monday. She will proceed later to the Clyde for her speed and other trials. A good impression of the handsome appearance of the new addition to the fleet of the Orient Line is given by Fig. 12, which was prepared from a photograph taken off Barrow as the vessel was leaving to cross the Irish Sea.

(To be continued.)

BOX-MAKING AND WOOD-PRINTING MACHINES.

In contrast with the old hand processes of wooden-box making, in which much labour and time were expended to obtain what was frequently not a satisfactory job, the newer methods of machine working have much to recommend them. By the use of a planing machine and saws, which can be easily and rapidly set to obtain the correct dimensions for base, top and sides of a particular standard box, production costs may be greatly reduced, as the output is high in relationship to the number of workers employed. Nailing the structure together is another operation in which savings, both in waste material and in time, may be attained by the use of suitable machines. Among the firms who have specialised in the design of machines for these purposes, one of the leading concerns is Messrs. Matthew Wylie and Co., Limited, of Portman Street, Glasgow, who show a selection of their box-making and printing machines at the British Empire Exhibition. Two examples of the machines made by the firm, a box-nailing machine and a box-printing machine, are shown in Figs. 1 to 3 opposite.

The nailing machine, shown in Fig. 1, is of the side arm type, provision being made for driving nails into the end of the box at the same time as they are being driven into one of the sides. It can be used to work with anything up to eight nails in a straight line, or two on the side arm and the rest in the normal length, at the same time. The sizes of nails used with the machine range from 1 in. to 2 in. in length, but provision can be made, when required, to deal with nails of greater length. Any pitch for the nails, down to a value of $1\frac{1}{2}$ in. may be obtained by the use of this machine, and a total spread of up to 24 in. is within its capacity. The nails driven in by the use of the side arm can be located up to 17 in. from the main row. The height of the table of the machine is adjustable, movement vertically up to 30 in. being possible.

This box-nailing machine has a cast-iron vertical frame provided with slides for the accommodation of the table, the vertical movement of which is obtained through a long screw and a handwheel. On the top of the machine frame the nail pan is situated. This is given a slow but continuous rocking motion to shake the nails into a series of feeder tracks. If two sizes of nails are to be dealt with at the same time a divided nail pan is used. The nail tracks may be rapidly adjusted for different sizes of nails. From each track the nails are carried one at a time to the hammer boxes by feed discs. These hammer boxes are so constructed that the nails are held perfectly straight whilst they are being driven, which ensures accurate working even when thin wood is dealt with. The driving is effected by the vertical motion of hammer rods attached to a crosshead, which receives its motion through a connecting rod on the main clutch shaft, the clutch on which is put into action by a pedal. The hammer boxes may be set in any position to suit the work in hand, the distances between them being variable at will. A side fence is provided, which is fitted to the hammer box bars and can be quickly set to the required spacing of the nails. On the main column there is a back fence, the top part of which has a spring motion, to ensure that all the nails are driven central into the wood. The driving or pulley shaft runs in dust-proof bearings. Machines for a direct electrical motor drive are also constructed as well as the type shown in the illustration.

In Figs. 2 and 3 are shown a wood-printing machine, used for the printing of names, trade marks and other signs in two colours on boxes, barrel heads, &c. The boards on which the printing is to be done are placed in a pile in front of the cylinders, and are fed through the machine quite automatically by two continuous running steel chains, with cross bars connecting them which feed forward one or two pieces, which make up the width of the box side or end. Adjustable guides are provided on the table to keep the boards in correct alignment. An adjustable guide rises and falls as the first printing cylinder turns. It keeps the pile of boards in proper place and has an opening at its lower edges, sufficient to allow the bottom board of the pile to pass to the cylinder for printing. The chain bars then carry this one through the machine at the same speed as the travel of the face of the printing plate. This action gives a continuous uniform speed and carries the boards forward at the proper times. If the boards are thin a kicker device replaces this chain feed. Prior to printing the boards are swept by a brush on the lower part of the adjustable guide to remove any sawdust or loose dirt. The cylinders are fitted with bevelled clamps and adjusting screws which hold the printing plates securely in position. These clamps are distributed around the cylinder, so that the plates can be located in any desired position. Ink is supplied to sets of composition rollers from a reservoir or fountain, and is very evenly distributed. Should a board get jammed when in the machine, either, or both, of two safety devices act to stop the machine. One of these is operated from the main driving gear, while the other is on the chain-driving sprockets at the delivery end. The printing plates used are made of brass or thelmite, and loose letters or figures in the same materials are also supplied. The machine shown in Figs. 2 and 3 will take boards up to 22 in. wide by 44 in. long, and from $\frac{1}{4}$ in. to $1\frac{1}{4}$ in. thick and requires 2-h.p. for its operation.

THE SIGNIFICANCE OF EXHAUST TEMPERATURE.*

By Mr. P. H. Smith.

When Messrs. Carels first brought out their high-speed semi-enclosed Diesel engine a number of innova-

* A Paper read before the Diesel Engine Users Association on Friday, October 3, 1924.

BOX-MAKING AND WOOD-PRINTING MACHINERY; EMPIRE EXHIBITION.

CONSTRUCTED BY MESSRS. MATTHEW WYLIE AND CO., LIMITED, ENGINEERS, GLASGOW.

(*For Description, see Opposite Page.*)

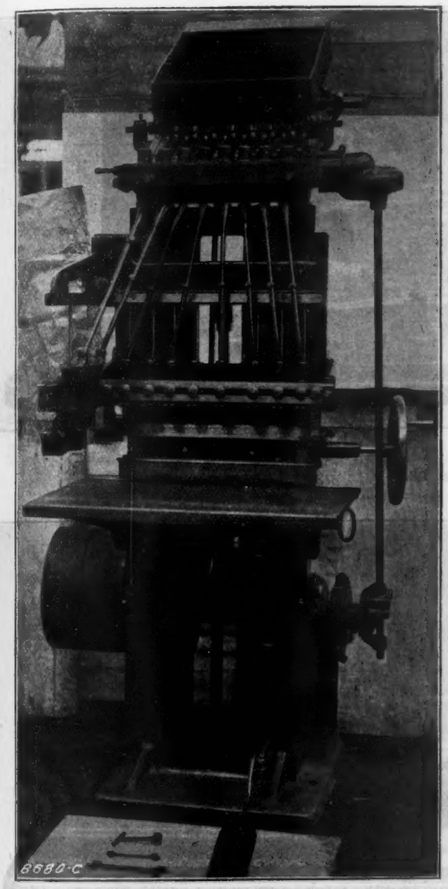


FIG. 1. SIDE-ARM NAILING MACHINE.

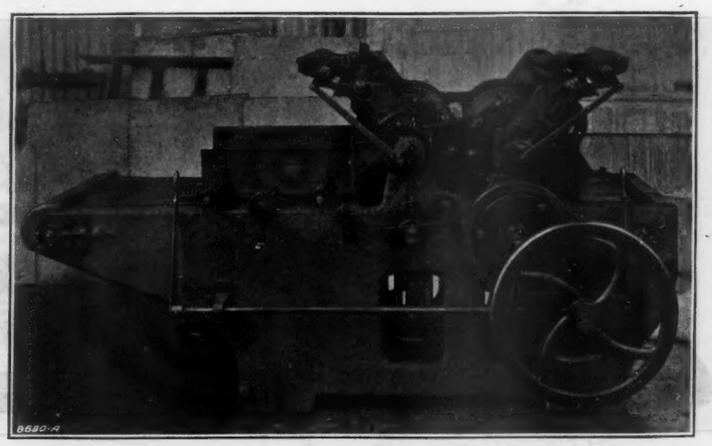


FIG. 2. TWO-COLOUR WOOD-PRINTING MACHINE: FRONT VIEW.

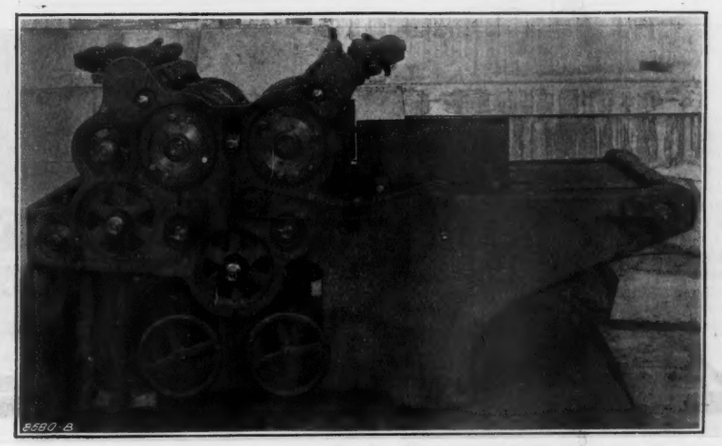


FIG. 3. TWO-COLOUR WOOD-PRINTING MACHINE: REAR VIEW.

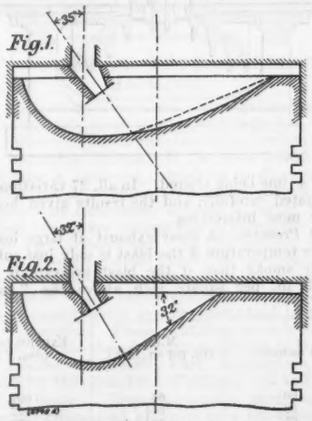
tions were introduced which collectively made the engine an unqualified failure at that time. The performance of this type of engine fell so markedly below that of the standard engine that the majority of the engines purchased were thrown back on the makers. A few remained, and their weaknesses were investigated and remedied, with the gratifying result that there are to-day examples of this type, originally a complete failure, which are in regular service and showing as fine a performance as the standard type. One such engine, which very narrowly escaped relegation to the scrapheap, was the 3-cylinder, 600 by 600 mm., 215 r.p.m. Diesel engine installed at Oxford. This set was rated at 600 brake horse-power, but actually 360 kw. was finally adopted as its safe maximum loading. Being the largest engine of this new Carels type, no pains were spared in its careful erection, and every effort was made in this direction to make it a show job, as the construction of the engine was such as to open to wide commercial possibilities were it successful. Various mechanical difficulties were encountered in the preliminary runs which were satisfactorily or fairly satisfactorily overcome, but the one problem which defied solution was the high fuel consumption; 0·53 lb. per brake horse-power hour was about the best result obtainable, and that at well below full load. Of course, the exhaust was very dirty. The indicator diagram from this engine was very different from that to which we had become accustomed, and in any case was obviously distorted. Therefore, it gave no clue to the root of the difficulty.

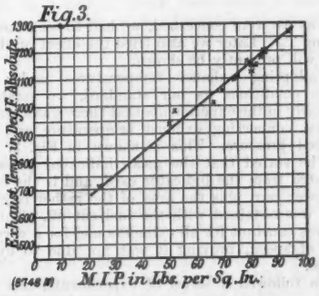
Here, let me take a short cut, and state that ultimately we traced the cause of the trouble to a wrongly shaped combustion space and a wrong method of fuel introduction into the combustion space. When this was appreciated we were able to formulate a sound principle to guide us in our further experiments, and that was as follows:

The fuel shall pass approximately through the centre of gravity of the combustion space, and the stream shall impinge approximately normally to the piston so long as a single jet flame-plate is used.

As showing how far the original design failed to approach this principle, you are recommended to examine Fig. 1. This was the original design, to scale, except as regards the flame-plate, which has been drawn much larger to emphasise another point to which reference will presently be made.

In juxtaposition with Fig. 1 is Fig. 2, showing the final design. In Fig. 1 it is clear that fuel injection cannot be made normal to the piston-head without causing the stream to pass far away from the centre of gravity. In this connection it is to be noted that the centre of gravity moves towards the axis as injection proceeds. When it was quite realised why this type of engine was such a failure an experimental piston was made, and on the first run up there was a marked improvement. As a matter of interest, the shape of piston selected, and as shown in Fig. 2, was not subsequently altered. It was hoped that the new shape of piston would cause the indicator card associated with the original piston to resume a more familiar shape. In this, however, we were disappointed, for the indicator card was as perplexing and distorted as hitherto. We therefore decided not to use the indicator card for tuning up, except for the rudimentary purpose of adjusting firing-point and compression. We decided,





THREAD-GRINDING MACHINE AT THE BRITISH EMPIRE EXHIBITION.

CONSTRUCTED BY WOLSELEY MOTORS, LIMITED, ENGINEERS, BIRMINGHAM.

(For Description, see opposite Page.)

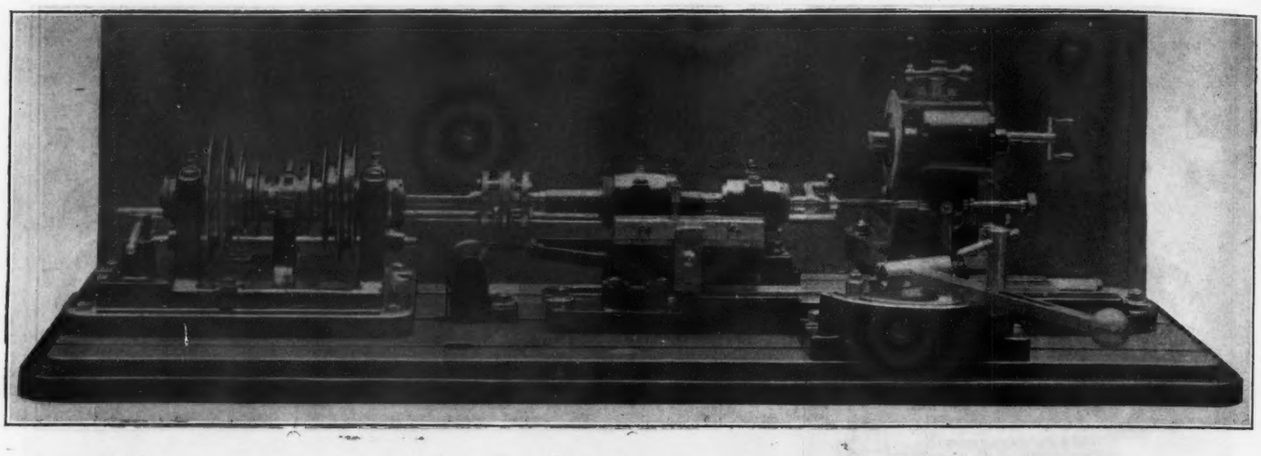


Fig. 1. Machine with Wheel Truing Device.

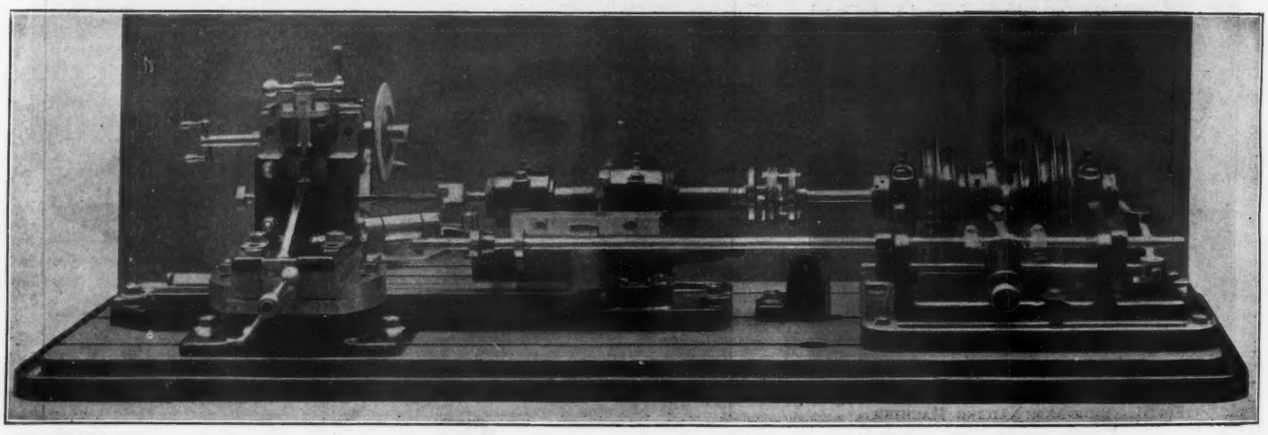


Fig. 2. View showing the Adjustments for the Grinding Wheel and the Reversing Gear.

instead, to be guided largely by exhaust temperature, for the obvious reason that our main trouble was lack of economy, and economy as defined in thermodynamics is

$$\frac{T_1 - T_2^*}{T_1}.$$

So far as we were concerned, we had to seek means of reducing T_2. Later we also tried the effect of altering T_1, as will presently be shown.

In adopting exhaust temperatures under comparable conditions as our standard, we established quite early in the experiments that there was a straight-line law connecting exhaust temperature and mean indicated pressure. This is shown in Fig. 3. Here let it be stated that the mean indicated pressure is calculated from the indicator card, and is the area of the power card plus the area of the rather large loop which was obtained with the fuel cut off. This loop area was constant for all cylinders and for a very wide range of speed, proving it was not due to cylinder leakage.

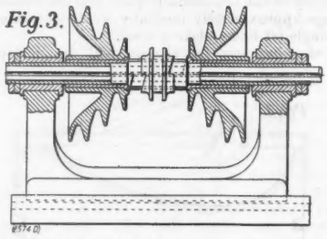
Then followed a series of experiments, one factor

Shape of Combustion Space—

Shape.	M.I.p. (lb. per sq. inch).	Exhaust temp. (deg. F.).
Old piston as in Fig. 1	81·4	765 after 15 min. 795 ,, 60 ,,
New piston as in Fig. 2	81·6	660 ,, 10 ,, 665 ,, 15 ,,

* Note.—T_1 and T_2 represent the temperatures of the working fluid at the beginning and end of the impulse stroke.

Fig. 3.



only at a time being altered. In all, 27 variations were investigated carefully, and the results given herewith are the most interesting.

Blast Pressure.—A clear exhaust at large load has a higher temperature if the blast is only just sufficient to clear smoke than if the blast pressure is raised 100–150 lb. per square inch above the "smoking point."

Blast (atmos.).	M.I.p. (lb. per sq. inch).	Exhaust temp. (deg. F.).
50	66	697
58	66¼	652
65	66¼	663

Flame-Plate.—The difference between the original flame-plate and the final, as shown in Figs. 1 and 2 respectively, was as in the next column.

It is unfortunate, in this experiment, that blast pressures were not equal. If, however, we add 50 deg. F. to the exhaust temperature in the second test, a figure warranted by results recorded under sub-heading "Blast Pressure," we are still vindicating the flame-plate shown in Fig. 2 as compared with Fig. 1.

Flame Plate.	M.I.P. (lb. per sq. in.)	Blast (atmos.).	Exhaust temp. (deg. F.).
Original (Fig. 1) ..	68·4	50	720
Final (Fig. 2) ..	69·2	56	610

Fuel Admission Period.—After securing consistent results with normal cylinder pressure, viz., 38–39 atmospheres at full load with 65–70 atmospheres blast pressure, the effect of retarding the timing was tried. It was found that by reducing the peak of the diagram the exhaust temperature was increased. The actual figures are given as follows :—

Fuel Admission (degrees before top dead centre).	M.I.P. (lb. per sq. in.)	Blast Pressure (atmos.).	Exhaust temp. (deg. F.).
Normal 9 deg. ..	80·1	65	675
,, 8 ,, ..	79·2	65	720
,, 7 ,, ..	78·5	65	710

Pulveriser Rings.—Provided the area of the holes in the rings was well in excess of the minimum area of the flame-plate, i.e., 8 to 10 times, we got no difference in exhaust temperature with large variations of this particular factor.

The official trials of this engine, in the finish, were perfectly normal, and are given in curtailed form in Table I on the next page.

The value of the pyrometer was shown during these

THREAD-GRINDING MACHINE AT THE BRITISH EMPIRE EXHIBITION.

CONSTRUCTED BY WOLSELEY MOTORS, LIMITED, ENGINEERS, BIRMINGHAM.

Fig. 4.

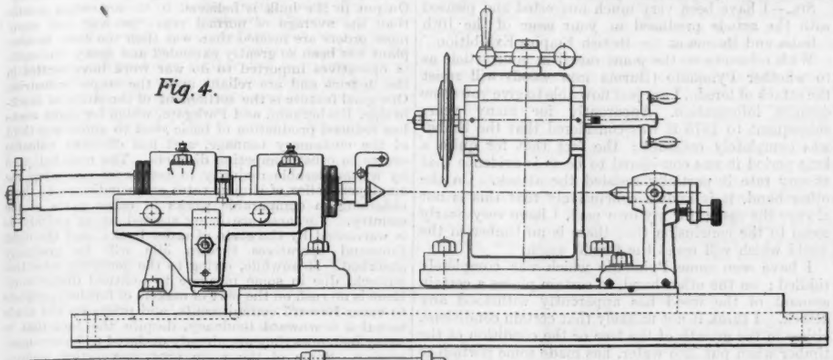


Fig. 5.

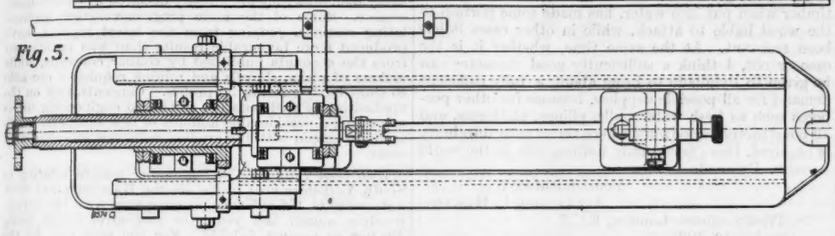


Fig. 6.

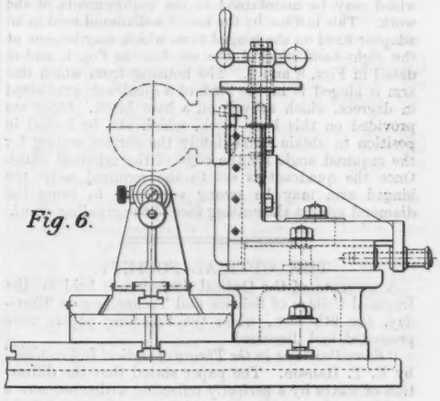


Fig. 7.

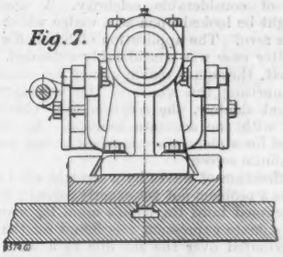


Fig. 8.

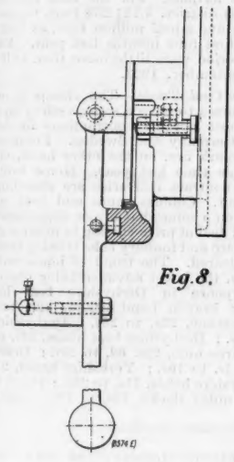
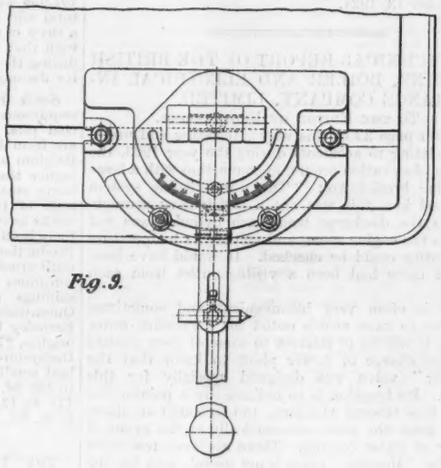


Fig. 9.



preliminary tests, and the customer thereafter recorded exhaust temperatures quite as a routine matter. Hence the records are interesting to compare service results

TABLE I.

Load.	Qtr.	Half.	Three. qtr.	Full.	381 kw.	423 kw.
Kw.	90·5	180·7	285	361	381	423
B.h.p.	142·6	269	421	526	555	616
M.i.p. lb., sq. in.	44	59	77	90	93	101
R.p.m.	214	215	214	213	215	213
Fuel per kw.-hour (lb.)	1·087	0·803	0·692	0·661	0·662	0·685
Fuel per b.h.p.-hour (lb.)	0·69	0·54	0·47	0·454	0·455	0·471
Fuel per i.h.p.-hour (lb.)	0·267	0·204	0·306	0·318	0·324	0·345
Blast (atmos.) ..	46	51	61	70	70	72
Exhaust temp. (deg. F.) ..	—	—	—	—	810°	—

TABLE II.

Date.	Load kw.	Exhaust temp (deg. F.).	Remarks.
April, 1913 ..	381	810	—
,, ,, ..	300	705	—
September, 1916..	276	688	—
January, 1917 ..	300	706	—
October, 1918 ..	300	—	—
	320	725	Tar oil.
	310	746	Fuel oil.
	250	622	Tar oil.
	250	630	Fuel oil.

with test-bed figures. Table II shows these results over a number of years, and attention is drawn to the fact that when operating on tar oil exhaust temperature appears rather lower than with ordinary fuel oil. This suggests that exhaust temperature is also a function of viscosity of fuel, for tar oil is very much thinner than normal fuel oil.

THE WOLSELEY THREAD-GRINDING MACHINE.

THE production of accurate screw gauges and also of screwing tools such as dies and taps has always proved difficult owing to the distortion troubles caused by the hardening process. If the work is accurately cut and later is hardened, variations in diameter may be created, but in addition pitch errors may be introduced which are exceedingly difficult to rectify. Some of the best results are obtained by grinding the thread after the work is hardened. By this method, if compensating devices are fitted to get over the irregularities introduced through the existence of pitch errors in the lead screw of the thread-grinding machine, results may be obtained which can be guaranteed to a great degree of precision. These conditions were recognised in the design of the thread-grinding machine of Wolseley Motors Limited, of Adderley Park, Birmingham, which is suitable for the production of gauges, taps and dies to very fine limits. These appliances made on this machine are guaranteed accurate to a ten-thousandth of an inch. One of these machines is available for inspection in the Research Laboratory on the stand of Messrs. Vickers Limited, at the British Empire Exhibition. Illustrations of this machine are given in Figs. 1 to 3 on page 546 and in Figs. 4 to 9 above. In this machine the hardened rod on which the thread is to be ground is moved along and rotated under a grinding wheel of suitable form and inclination, which is set in a fixed position on the bed of the machine. Compensation gear is provided to overcome the effects of irregularities of pitch in the lead screw and provision is also made for truing up the grinding wheel to the requirements of the work.

The machine, as is shown in Figs. 1 and 2, consists of a driving head, the main body, a grinding headstock and a wheel-truing device, all mounted upon a general base plate which may be set up on a bench or table. The driving head has three forward speeds and three reverse. Incorporated in it there is a sliding splined shaft driving the spindle carrying the lead screw in the main body. This drive is obtained through a flexible coupling. For the change from forward to reverse motion, automatic operation is obtained by means of a rod on which are mounted adjustable stop collars (see Fig. 2). These stops are set to the required traverse, and the motion obtained from the rod actuates the dog clutch, shown in Figs. 2 and 3, through a forked lever. Hand operation of the reversing motion is also possible, a lever being provided for the purpose. It is arranged that the speed of the return is double that of the forward motion, this requirement being met by the use of a geared countershaft.

The main body, the details of which are illustrated in Figs. 4, 5 and 7, has a base which is machined to take a Vee slide, with adjustable gib straps. On this base is mounted the headstock bracket in which the head screw nut rotates, see Fig. 5 where it is shown in section. To this nut a yoke arm for the pitch correction mechanism is attached at the end towards the main spindle, which transmits the drive to the work. This spindle is supported in a bracket where it is provided with suitable bearings. On the bracket, lugs are provided at the sides for the attachment of the sine bars. The pitch of the lead screw regulates the travel of the slide, which carries the work, which is to have threads ground upon it, and any compensation that may be necessary to correct the pitch errors in the head screw is obtained by canting the sine bars on which there are vertical pegs located in small slipper plates at their base in which they slide. By their use the lead screw nut may be turned in such a way as to lengthen or shorten the pitch to an extent depending solely on the amount and direction of the cant of the sine bars. The thread of the lead screw, it may be noted, is of the buttress form and is kept in complete engagement with that of the nut, which may be turned between two ball races, by means of suspended weights located beneath the machine, but attached to the bracket.

The grinding wheel, shown in Fig. 4, is driven by a small electric motor and is mounted on a slide in the angle bracket, as is shown in Fig. 6. Adjustment to the height required for the diameter of work under

treatment is effected by means of a feed screw provided with a handle at the top of the bracket. As the bracket for the support of the grinding wheel is located on a swivel plate it can be set to suit the helix angle of the thread for the work. The form of the grinding wheel may be maintained to the requirements of the work. This is done by the use of a diamond held in an adaptor fixed on the hinged arm, which may be seen at the right-hand side of the machine in Fig. 1, and in detail in Figs. 8 and 9. The housing from which this arm is hinged is in the form of a quadrant, graduated in degrees, which swivels on a base block. Stops are provided on this base block, which can be locked in position to obtain immediately the correct setting for the required angle for the edge of the grinding wheel. Once the quadrant is set to the required angle the hinged arm may be swung vertically to bring the diamond against the cutting face of the grinding wheel.

THE OPTICAL SOCIETY.

A MEETING of the Optical Society was held at the Imperial College of Science and Technology on Thursday, the 9th inst., when the following papers were presented and discussed.

"*Some Problems in the Theory of Optical Diffraction*," by E. T. Hanson. The paper stated that the diffraction of waves by a perfectly reflecting wedge was now a problem of considerable celebrity. A semi-infinite plane might be looked upon as a wedge whose internal angle was zero. The application of Kirchoff's formula in the latter case was considerably extended, it being shown that, through a region of not too small dimensions comprising the whole of the boundary of the geometrical shadow, the solution thus obtained was identical with the accurate solution. An expression was found for a plane wave incident at any angle upon a semi-infinite screen.

The diffraction of waves by a straight slit in a plane screen was a problem not yet exactly solved; it was one which occupied Lord Rayleigh's mind for many years. An approximate expression was found for the disturbance distributed over the slit due to a wave incident normally, and by an application of Kirchoff's formula an important result was obtained very readily, which was in agreement with Rayleigh's investigation by very long analysis. This appears to be the first time that an attempt has been made to apply Kirchoff's formula to an area of disturbance which is not considered to be uniform over the area. The paper gave a brief treatment of the foregoing points of novelty and interest in these two problems which have long been, and still are, of some importance in mathematical physics.

"*The Annealing and Re-Annealing of Glass*," by W. M. Hampton. In this paper the factors which play an important part in the annealing of glass were discussed. Relations connecting the strains present when cooling commences, strain due to gradient, and strain present after cooling were obtained and the equations were applied to the case of slabs. Tables showing the proportion of temporary strain remaining as permanent strain for different kinds and sizes of slabs were given. The considerations affecting the temperature at which annealing is carried out and the conditions for the total annealing and cooling times to be a minimum were then dealt with. The effect of errors in pyrometry were discussed and tables giving annealing temperature, annealing time and rate of cooling for various kinds of glass were included.

THE MOTOR-VESSEL "MOVERIA."—The first oil engine propelled vessel to be ordered by the Donaldson Line, Limited, for their trade in carrying live cattle, general cargo and carcases from Canada, was launched at the Barrow-in-Furness yard of Messrs. Vickers Limited, on Friday, October 10. This vessel, the m.v. Moveria, is propelled at 11½ knots, by a single eight-cylinder oil engine of the four-stroke single-acting type. The cylinders are 30-in. diameter and the stroke is 45 in., and the total power generated is 2,700 brake horse-power. Compressed air is used for starting and reversing only, the oil being forced into the cylinders by pumps on the solid injection system. This engine, it is interesting to note, is the largest of its type afloat.

THE FORMATION OF CLINKERS IN BOILER FURNACES.—Experiments have been carried out by the American Bureau of Mines with a view to determining the relationship between the ash-softening temperatures and the clinkering of coals in a boiler furnace. From the records of 27 coals of substantially the same analysis, it appears that the ash-softening temperature varied from 2,200 deg. F. to 2,882 deg. F. Heavy troublesome clinkers were formed with the three coals having ash-softening temperatures below 2,300 deg. F. Troublesome clinkers occurred with practically all the 16 coals having ash-softening temperatures from 2,300 deg. F. to 2,500 deg. F., and there was little or no clinkering with the eight coals with ash-softening temperatures higher than this. Softening temperature is defined as the temperature at which a small cone of the ash, when tested in a laboratory furnace, has fused down into a spherical lump.

LETTERS TO THE EDITOR.

THE TEREDO WORM.

To the Editor of Engineering.

SIR,—I have been very much interested and pleased with the article produced in your issue of the 10th "India and Burma at the British Empire Exhibition."

With reference to the point raised in your article as to whether Pyinkado (Burma iron wood) will resist the attack of teredo, I am just now able to give you some definite information. Apparently for many years subsequent to 1875 it was considered that the timber was completely resistant; the fact that for quite a long period it was considered to be so is evidence that at any rate it partially resisted the attack. On the other hand, it is known conclusively that this is not always the case; for my own part, I have very nearly come to the conclusion that there is no timber in the world which will resist the teredo worm.

I have seen some Pyinkado which was completely riddled; on the other hand, in certain places a certain amount of the wood has apparently withstood any attack. I think it not unlikely that certain conditions, either in the growth of the tree or the condition of the timber when put into water, has made some portion of the wood liable to attack, while in other cases it has been resistant. At the same time, whether it is the case or not, I think a sufficiently good character can be given to Pyinkado to bring about a fully sufficient demand for all possible supplies, because for other purposes such as fresh water walls, pilings, platforms, and all constructive woodwork where the utmost durability is required, there is certainly nothing else in the world equal to Pyinkado.

Yours faithfully,
ALEXANDER L. HOWARD.

38, Trinity-square, London, E.C.3.
October 13, 1924.

THE TECHNICAL REPORT OF THE BRITISH ENGINE, BOILER AND ELECTRICAL INSURANCE COMPANY, LIMITED.

To the Editor of Engineering.

Sir,—On page 33 of this very interesting and useful report relating to accidents during the year 1923, the following observation occurs, in connection with a large gas engine breakdown: "The water-cooling system was closed in; this was not a satisfactory arrangement, as the discharge from each cylinder was not visible in the engine room, and neither its temperature nor quantity could be checked. It would have been better if there had been a visible outlet from each line."

As it is often very inconvenient and sometimes impossible to have visible outlet for the cooling-water systems, it will be of interest to some of your readers who have charge of power plant to know that the "Monitor" valve was designed specially for this purpose. Its function is to indicate by a pointer the relative flow through the pipe, and to sound an alarm or shut down the plant automatically in the event of the flow of water ceasing. There are very few cases where the "Monitor" valve is not useful, both for the open and closed circuit, and I shall be pleased to give any of your readers free advice in cases where they are contemplating the adoption of the "Monitor" safety device.

Yours faithfully,
CHAS. L. STOKOE.

Laburnum-avenue, Wallsend-on-Tyne.
October 14, 1924.

[We published a full, illustrated description of the safety device referred to in ENGINEERING, May 11, 1923, vol. cxv, page 584.—ED.]

HIGH-FREQUENCY ELECTRIC MEASUREMENTS.—Professor J. A. Fleming will deliver a course of six lectures on "High-frequency Electric Measurements," at University College on Wednesdays, at 5 p.m., beginning on October 29. A syllabus of the lectures and particulars as to fees may be had on application to the Secretary, University College, London, W.C. 1.

AN ENGINEERS' CLUB FOR BIRMINGHAM.—For some years engineers in the Birmingham district have discussed the formation of a club similar to that which has been so successful in Manchester, and the project has now taken definite shape by the securing of an option on suitable premises in Station-street, practically adjoining New-street station. The proposed club-house will contain 16 bedrooms for the convenience of the members, in addition to the usual public rooms. Membership will be open to all professional men connected with the engineering industry. There will be no entrance fee for the first members, and the annual subscriptions for town and country members are very moderate. Intending members should communicate at once with Mr. A. R. Page, care of the Birmingham Small Arms Co., Limited, Birmingham.

NOTES FROM SOUTH YORKSHIRE.

SHEFFIELD, Wednesday.

Iron and Steel.—It is difficult to determine whether the position shows any improvement compared with a month ago or whether it is not slightly less satisfactory. Output in the bulk is believed to be somewhat greater than the average of normal years pre-war, but many more orders are needed than was then the case, because plant has been so greatly extended and many thousands of operatives imported to do war work have settled in the district and are reliant upon the staple industries. One good feature is the settlement of the strike at Stockbridge, Rotherham, and Parkgate, which for eight weeks has reduced production of basic steel to about one-third of the customary tonnage, and has diverted valuable orders to other competing districts. The men ballotted by a considerable majority in favour of accepting the employers' offer of similar rates and conditions to those obtaining in comparable works in other parts of the country. Furnaces are being started up as quickly as is warranted by the state of order books, and the eight thousand operatives thrown idle will be gradually absorbed. Meanwhile, owing to the generally unsettled outlook, due in some measure to political disturbance, there is no rush on the part of makers of finished products to cover forward commitments, and prices on the whole reveal a downward tendency, despite the fact that in many instances they are already declared to be unremunerative. Some of the more progressive steel manipulating sections, judging from the latest reports, have produced more favourable results than was anticipated from the accounts published by similar concerns, while makers of picks, shovels and mining requisites are able to show fairly substantial profits. Concentration on the application of rust-resisting metals to engineering use is attracting a considerable amount of new business, which tends to spread with the gradual reduction of production costs.

Hull Coal Traffic.—The September returns relating to South Yorkshire coal traffic *via* the Humber ports show a decrease of 126,597 tons, as compared with the corresponding month last year, the respective totals being 404,958 as against 531,555. For the nine months the total sent from this district, 3,721,235 tons, represented a drop of over one and a half million tons, as compared with that for the first nine months last year. Exports during the same period were little more than half those for January to September, 1923.

South Yorkshire Coal Trade.—The slump in export requirements continues to have a serious effect on steam coal pits. The most notable contractions in demand are from France, Germany and Sweden. Purchases by Belgium and Denmark are, on the other hand, slightly higher than at this time last year. Home buying is fairly steady and contract deliveries are absorbing the bulk of the output. Cobbles, nuts and best quality slacks have taken on a somewhat firmer appearance, but there is still a good deal of price-cutting in inferior grades. Production of furnace and foundry coke is being restricted until stocks are cleared. The trend of housecoal price continues upwards, the latest advance being one of two shillings and sixpence in Derbyshire best brights. Quotations:—Best branch hand-picked, 32*s.* to 35*s.*; Barnsley best Silkstone, 26*s.* to 28*s.*; Derbyshire best brights, 27*s.* to 32*s.*; Derbyshire best house, 24*s.* to 26*s.*; Derbyshire best large nuts, 22*s.* 6*d.* to 25*s.*; Derbyshire best small nuts, 14*s.* to 16*s.*; Yorkshire hards, 21*s.* 6*d.* to 23*s.* 6*d.*; Derbyshire hards, 21*s.* to 23*s.*; rough slacks, 11*s.* to 13*s.* 6*d.*; nutty slacks, 10*s.* to 12*s.*; smalls, 6*s.* to 8*s.* 6*d.*

THE TRANSATLANTIC JOURNEY OF THE AIRSHIP "Z.R.3."—The Zeppelin airship Z.R.3, built in Germany for the United States Navy, was successfully landed at Lakehurst, New Jersey, on Wednesday morning, the 15th instant, having completed the 5,000-mile journey from Freidrichshafen in 80 hours 45 minutes. The petrol supply, it is understood, was sufficient for a further flight of 20 hours' duration, in spite of the fact that heavy gales were encountered during the latter part of the journey, the head winds attaining a velocity of 50 m.p.h. to 60 m.p.h. The Z.R.3 is 656 ft. in length, 90 ft. 6 in. in maximum diameter, and has a gas capacity of 2,470,000 cub. ft., giving a gross lift of 80 tons and a disposable lift of 40 tons. Her maximum speed is stated to be 76 m.p.h., and her normal cruising speed 67 m.p.h. It will be remembered that the British airship R.34 made a double transatlantic journey in July, 1919, flying from East Fortune, in Scotland, to Mineola, Long Island, a distance of 3,130 miles, in 108 hours, while the return journey was completed in 75 hours.

SIR CHARLES PARSONS' EARTH-BORING SCHEME.—At a luncheon given on September 26, at the Engineers' Club, New York, in honour of Sir Charles Parsons, Sir Charles Morgan, Mr. W. H. Patchell and Senatore Luigi Luiggi by the four national engineering societies of America, Sir Charles Parsons invited international co-operation in his scheme for sinking a shaft 12 miles into the earth. Such an exploration, Sir Charles said, might reveal the existence of new elements and of metals heavier than those at present known. Preliminary investigations of the possible methods of construction had been made, and it was thought to be a practical engineering project. No return of a financial nature could be anticipated from the endeavour, but information of great scientific importance might be obtained, and the venture must be regarded as of equal importance to polar exploration. Senatore Luiggi, President of the Society of Italian Engineers, later advocated the private ownership of public utility services because of the inefficiency generally shown in State management.

NOTES FROM CLEVELAND AND THE NORTHERN COUNTIES.

MIDDLESBROUGH, Wednesday.

The Cleveland Iron Trade.—There was only a thin attendance at the weekly market, the tone of which was again cheerless, and the election appeared to be more discussed than was business. Cleveland pig-iron was in ample supply for needs, but was by no means abundant, and makers were somewhat markedly disinclined to acknowledge further fall in values, though on the other hand, customers considered prices asked were too high. Producers protested that quotations were already unremunerative, and adhered to 85*s.* for No. 1 quality, 80*s.* for No. 3 grade, 79*s.* for No. 4 foundry, and 78*s.* for No. 4 forge.

Hematite.—There is little new in the East Coast hematite branch. With curtailed output, makers are disposed to take a rather firmer stand, but supply is still very plentiful, and producers are anxious to liquidate their large stocks. Nos. 1, 2 and 3 are 88*s.*; and No. 1 is quoted 6*d.* above mixed Nos.

Foreign Ore.—Sellers of imported ore experience as much difficulty as ever in arranging contracts, consumers continuing to hold off the market. Quotations are based on best rubio at 21*s.* 3*d.* c.i.f. Tees.

Blastfurnace Coke.—Durham blastfurnace coke is in only very moderate request. Good medium qualities are on sale at 25*s.* delivered to local users.

Ironstone Miners' Wages.—Under sliding scale arrangements, Cleveland ironstone mineowners are entitled to reduce wages by 5·2 per cent., but when the owners met the miners' representatives at Middlesbrough this week they sympathised with a strong appeal made by the latter and decided to make no reduction. Thus wages for the present quarter remain at 78 per cent. above the base rate.

Manufactured Iron and Steel.—Finished iron and steel materials continue very slow of sale, and prices are weak. A 10*s.* reduction made in plates, angles, and joists is only what was anticipated, but hope is expressed that the actual fall will stimulate buying to some extent. Among the principal market quotations for home business are: Common iron bars, 12*l.* 10*s.*; iron rivets, 14*l.* 5*s.*; packing (parallel), 9*l.*; packing (tapered), 12*l.*; steel billets (soft), 8*l.* 10*s.*; steel billets (medium) 9*l.*; steel billets (hard), 9*l.* 10*s.*; steel rivets, 14*l.* 15*s.*; steel boiler plates, 13*l.*; steel ship, bridge and tank plates, 9*l.* 15*s.*; steel angles, 9*l.* 10*s.*; steel joists, 9*l.* 10*s.*; heavy steel rails, 9*l.*; fish plates, 13*l.*; and galvanised corrugated sheets (24-in. gauge, in bundles), 18*l.* to 18*l.* 5*s.*

NOTES FROM THE NORTH.

GLASGOW, Wednesday.

Scottish Steel Trade.—Movement in the Scottish steel trade is still of a very restricted nature and specifications are most difficult to secure. The demand for plates and sections is very limited and much plant is not being operated at the present time. One of the main causes of the dullness at the various works is that very severe competition is being experienced for almost anything on offer. Not only have the local producers to face low prices from the Continent, but makers south of the border are also submitting very keen quotations. To meet this, the Scottish steel makers decided to make a reduction of 10*s.* per ton in the price of plates and sections as from Monday of this week, making the current quotations as follow:—Boiler plates, 13*l.* per ton; ship plates, ¼ in. and up, 9*l.* 15*s.* per ton; and sections, 9*l.* 10*s.* per ton, all delivered Glasgow stations, and subject to the usual extras and conditions. The export prices are very poor and unremunerative. Black sheet makers are doing fairly well, especially in export, as large lots are booked and regular shipments are being made of galvanised and corrugated sheets to India, South Africa and South America. The current home price is 12*l.* 10*s.* per ton for sheets, $\frac{1}{16}$ in. to ¼ in., delivered Glasgow stations.

Malleable Iron Trade.—Conditions in the West of Scotland malleable iron trade must still be reported as very disappointing. Not only is the amount of work on hand exceedingly poor, but fresh bookings—those that are being secured—are of small tonnage. This applies both to the home demand and to shipment lots. In the re-rolled steel branch of the trade, quietness is general with prices tending to sag. "Crown" bars are quoted without change at 12*l.* 10*s.* per ton, delivered Glasgow stations.

Scottish Pig-Iron Trade.—No change has taken place in the Scottish pig-iron trade over the week, and a dull tone prevails. There is only a small demand on home account, while that for shipment lots is just about as poor as it could possibly be. The output is much restricted at present, and there is a decided possibility of a further curtailment before long as stocks are accumulating. Prices are unchanged but have an easier tendency, and are as follow:—Hematite, 4*l.* 15*s.* per ton delivered at the steel works; foundry iron, No. 1, 4*l.* 15*s.* per ton; and No. 3, 4*l.* 10*s.* per ton, both on trucks at makers' yards.

Scottish Pig-iron Shipments.—The shipments of Scottish pig-iron from Glasgow Harbour for the week ended last Saturday, October 11, were again small and only amounted to 519 tons 13 cwt. Of that total, 478 tons 13 cwt. went overseas and the balance of 41 tons went coastwise. For the corresponding week of last year the figures were 1,694 tons foreign and 119 tons coastwise, making a total shipment of 1,813 tons.

Institution of Engineers and Shipbuilders in Scotland.—The first meeting for the ensuing session of the Institution of Engineers and Shipbuilders in Scotland was held on Tuesday last in the hall, Elmbank Crescent, Glasgow. The President, Mr. J. Howden Hume, in his presidential address, referred to the present disastrous condition of affairs in trade, and said that it had been brought about largely by the loss of our export business. This, he thought, was due to the change in the financial equilibrium of the world caused by the war, as nations which were formerly our best customers were now unable to pay the prices of our manufacturers, and could themselves produce the goods at lower costs than ours. The shipbuilding industry had been adversely affected to a serious extent by the Washington Treaty, as a result of which employment had been greatly decreased, and many of our best artisans had emigrated, while the collapse of the world's markets and the over-production of merchant ships during and immediately after the war had also a bad effect on shipbuilding. Now the Dawes scheme, thoroughly well intentioned and altruistic though it was, would, he was afraid, be equally disastrous to the industry. At the close, on the motion of Mr. Harold E. Yarrow, the president was thanked for his address, and afterwards a paper entitled "Pulverised Fuel in its Commercial Aspect" was read by Mr. Alfred J. T. Taylor, of Toronto.

NOTES FROM THE SOUTH-WEST.

CARDIFF, Wednesday.

The Coal Trade.—The present condition of the Welsh coal trade shows little alteration. Most classes of coal continue in excess of the demand despite a considerable reduction in the output due to numerous pit stoppages and irregular working. The undertone of the market, however, is somewhat better and the feeling for November is distinctly brighter so far as the volume of business is concerned. A fair number of inquiries are circulating for delivery next month from all over the world but it yet remains to be seen whether they are of a genuine character or in the nature of "feelers." The Argentine Navy want prices for 30,000 tons of best large coal over the next three months. The French Midi Railway also want prices for 110,000 tons of large and through coal, chiefly Monmouthshires for locomotives, and 45,000 tons of patent fuel with delivery over the whole of next year. Other smaller inquiries are also circulating. Meanwhile anthracite coals are exceedingly scarce and firm on the basis of 52*s.* 6*d.* for Big Vein large and 60*s.* for machine-made cobbles, with the result that an improved demand has been created for sized coals and best dry large as a substitute. Best dry nuts command up to 31*s.* with semi-bituminous up to 26*s.* and bituminous 24*s.*, while best dry large is up to 28*s.* Other grades of coal, however, are in abundant supply with the exception of best steam smalls which are steady at 14*s.* 6*d.* to 15*s.* Best Admiralty large rules from 27*s.* to 27*s.* 6*d.* with seconds from 24*s.* 6*d.* to 25*s.* 6*d.* and Monmouthshires from 23*s.* to 25*s.*, while smalls range from 11*s.* to 14*s.* Exports of coal as cargo from South Wales last week amounted to 460,700 tons as against 381,140 tons in the previous week. Shipments to France amounted to 151,553 tons compared with 167,267 tons, to Italy 56,014 tons against 51,321 tons, to South America 90,685 tons against 39,599 tons, and to British coaling depots, 50,034 tons against 38,021 tons.

Iron and Steel.—Exports of iron and steel goods from South Wales in the past week totalled 14,876 tons compared with 21,152 tons a week ago. Shipments of tinplates and terneplates amounted to 5,257 tons against 12,589 tons; blackplates and sheets totalled 561 tons against 4,516 tons: galvanised sheets to 5,137 tons against 2,630 tons and other iron and steel goods to 3,921 tons against 1,318 tons.

ELECTRICITY IN CANADA.—The Hydro Electric Commission of Ontario, which supplies practically the whole of the electricity used in the Province, has now 320,000 customers, and the average domestic user in Ontario gets his light and power for a cost of about 4*s.* per month.

THE LATE MR. CAMPBELL THOMSON.—A prominent Indian railway engineer, Mr. Campbell Thomson, died at the age of 78 years, at Tunbridge Wells on October 13. He entered the Indian Public Works Department in 1869, and after obtaining a valuable experience of railway work in Bengal, he was appointed executive engineer in 1880. After fourteen years' service in this capacity he was promoted superintending engineer. Further responsibilities were given him in 1898, when he was appointed Deputy Engineer-in-Chief of the Southern section of the North Western Railway. The following year Mr. Campbell Thomson was made chief engineer of the whole system, consisting of 5,000 miles of track, and this post he held until he retired in 1909.

THE D. B. MORISON ENGINEERING SCHOLARSHIP.—Mr. Reginald Porter, of West Hartlepool, has been awarded, on the results of a competitive examination, the first D. B. Morison Engineering Scholarship. This scholarship, which is of the value of 150*l.* a year, was founded by Mr. Morison to enable the best apprentice each year in the works of Messrs. Richardsons, Westgarth and Co., Limited, to obtain additional instruction over that provided under the Apprentice Advancement Scheme, which has been in operation for twenty-two years. By this scholarship the recipient is enabled to take a year's classes at the Armstrong College, Newcastle to complete the training in the West Hartlepool Technical College under the old scheme of apprentice training.

NOTICES OF MEETINGS.

THE JUNIOR INSTITUTION OF ENGINEERS.—To-night at 7.30 p.m., at the Royal Society of Arts, John-street, Adelphi, W.C. 2. Lecture: "High-Voltage Electric Oscillations," by Mr. R. P. Howgrave Graham. Friday, October 24, at 7.30 p.m., at 39, Victoria-street, S.W. 1. Lecturette: "Powdered Fuel," by Mr. F. F. Evans.

THE NORTHAMPTON ENGINEERING COLLEGE ENGINEERING SOCIETY.—Monday, October 20, at 5.30 p.m., at St. John-street, Clerkenwell, E.C. 1. Presidential Address, by Mr. S. C. Laws, M.A., M.Sc.; also "The Power of the Flame," a cinema film on welding, presented by Captain Richardson.

THE BRADFORD ENGINEERING SOCIETY.—Monday, October 20, at 7.30 p.m., at the Bradford Technical College. Lecture: "The Manufacture of Forgings," by Mr. F. Somers, M.I.Mech.E.

THE INSTITUTE OF TRANSPORT.—Tuesday, October 21, at 5.30 p.m., at the Institution of Electrical Engineers, Victoria Embankment, W.C. 2. Lecture: "Locomotive Running," by Mr. W. G. P. Maclure.

THE INSTITUTE OF MARINE ENGINEERS.—Tuesday, October 21, at 6.30 p.m., at 85–88, The Minories, Tower Hill, E. 1. "Present Tendencies in Steam Generation," by Sir Jas. Kemnal.

THE MANCHESTER METALLURGICAL SOCIETY.—Tuesday, October 21, at 7 p.m., at the College of Technology, Manchester. "Non-metallic Inclusions in Steels," by Mr. A. McCance, D.Sc.

THE MIDLAND INSTITUTE OF MINING ENGINEERS.—Wednesday, October 22, at 2.30 p.m., in the Metallurgical Theatre, Sheffield University, St. George's-square, Sheffield. "The Collieries of the First Danube Steam Navigation Company (D.D.S.G.), near Pécs (Funfkirchen), Hungary," by Dr. J. Herczegh. Papers open for discussion: (1) "The Theory of Ventilation: A Review of its Present Treatment," by Professor Douglas Hay, B.Sc.; (2) "The True Effect of Natural Ventilation in Deep Mines," by Mr. Robert Clive; (3) "Flame-Proof Design of Casings for Electrical Apparatus," by Professor Douglas Hay and Mr. I. C. F. Statham.

THE INSTITUTION OF ENGINEERING INSPECTION.—Wednesday, October 22, at 5.30 p.m., at the Royal Society of Arts, John-street, Adelphi, W.C. 2. "Crankless Engines," by Mr. A. Hamilton.

THE INSTITUTION OF CIVIL ENGINEERS: YORKSHIRE ASSOCIATION.—Thursday, October 23, at 7.30 p.m., at the Griffin Hotel, Boar-lane, Leeds. Presidential Address, by Mr. G. A. Hart, M.Inst.C.E.

THE INSTITUTION OF WELDING ENGINEERS.—Thursday, October 23, at 8 p.m., at the Engineers' Club, Coventry-street, W. 1. "Steel Wire: Its Manufacture, Properties, and Uses for Welding and Other Purposes," by Mr. E. A. Atkins, M.I.Mech.E.

THE INSTITUTION OF ELECTRICAL ENGINEERS.—Thursday, October 23, at 6 p.m., at Savoy Place, Victoria Embankment, W.C.2. Inaugural address by Mr. W. B. Woodhouse.

THE INSTITUTION OF MECHANICAL ENGINEERS.—Friday, October 24, at 6 p.m., at Storey's-gate, S.W.1. "The Missing Pressure in Gas Engines" and "Heat Loss in Gas Engines," by Professor W. T. David, M.A., Sc.D.

THE MANCHESTER ASSOCIATION OF ENGINEERS.—Friday, October 24, at the Engineers' Club, Albert-square, Manchester. "Costing and Works Accounting, with Special Reference to Engineering," by Mr. K. Dunkerley.

THE HULL ASSOCIATION OF ENGINEERS.—Saturday, October 25, at the Municipal Technical College, Park-street, Hull. Lecture: "Modern Constructional Plant and Its Application," by Mr. Ivan W. Benson.

ELECTRICITY SUPPLY AT LEEK.—For the year ending March 31, 1924, the Electricity Works of the Leek Urban District Council had an output of 1,642,000 kw.-hours, which were sold at an average price of 2·8*d.* per kw.-hour, which is remarkably cheap, considering the small size of the undertaking. The power is generated entirely by internal combustion engines, and the plant has just been increased by a 600 brake horse-power National vertical tandem gas engine, which is a duplicate of an engine installed in 1922. It is said that for the past two or three years there has never been even a temporary or partial failure of the supply. The engineer to the Council is Mr. H. A. Tulloch.

LYMPNE TRIALS OF TWO-SEATER LIGHT AEROPLANES: ADDENDUM.—In connection with an article on the above subject, which appeared in our last issue, on page 525, we are informed by the Air Ministry that while the results so far achieved are sufficient to warrant the formation of a few light-aeroplane clubs, the Ministry does not feel justified in recommending the adoption of any existing types of dual-control aeroplane for the use of such clubs until the engine question has been considered further. The aeroplanes taking part in the trials, the Air Ministry points out, proved themselves to be thoroughly efficient and satisfactory, and, with the power plants installed, they were able to carry out the prescribed tests, which included a 10-hours' reliability test. It was necessary, however, to run the engines at very high speeds in order to attain the maximum performance required for the competition, and reliability suffered in consequence. The Ministry, therefore, is now reviewing the whole position with regard to engines for the proposed club machines, in order to obtain the necessary technical data apart from the adverse conditions existing in the competitive trials.

PIPE LINE FROM LAKE TANSA FOR THE BOMBAY WATER SUPPLY.

(*For Description, see Page* 562.)

Fig. 1. Section of Pipe After Leaving the Rolls.

Fig. 2. Placing Pipe Sections in Position by means of a Goliath Crane.

Fig. 3. Pipes Completed in Place ready for the Refilling of the Trench.

Fig. 4. Bend in the Pipe Line.

Fig. 3. Pipes Completed in Place ready for the Refilling of the Trench.

Fig. 4. Bend in the Pipe Line.

TWIN-SCREW GEARED TURBINE STEAMSHIP

CONSTRUCTED BY MESSRS. VICKERS LIMITED, ENGINEERS A

(For Description see Page 54)

Fig. 1. PROFILE.

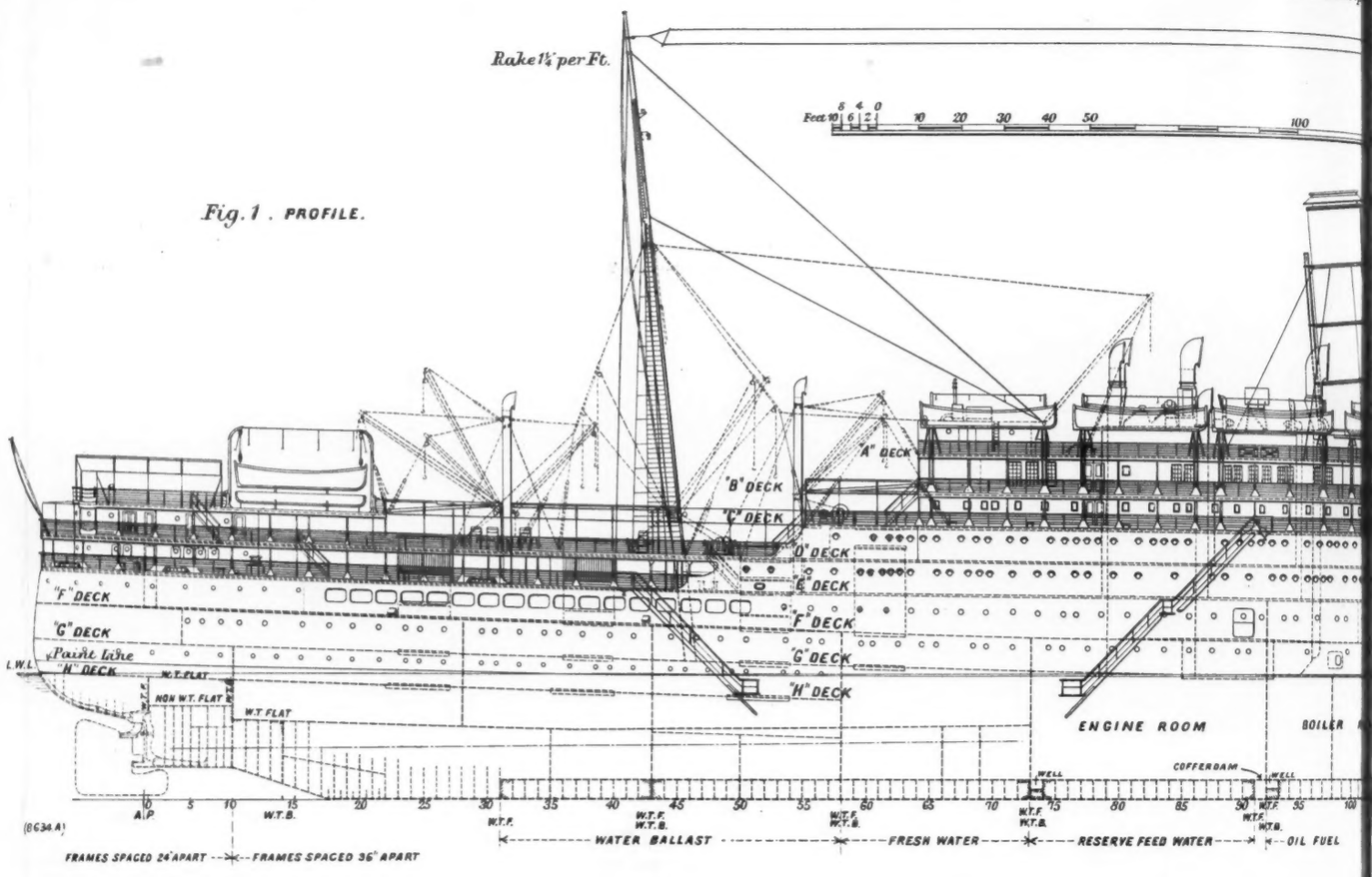


Fig. 2. "A" (BOAT) DECK

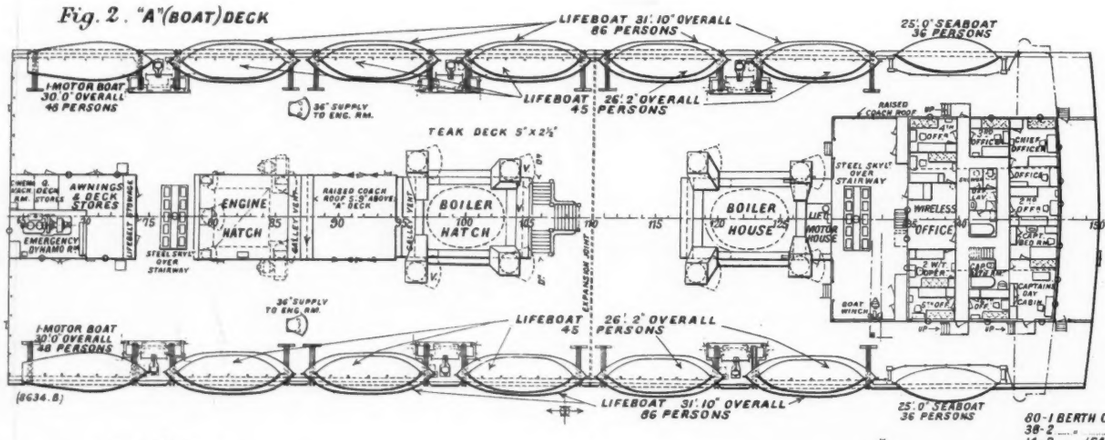


Fig. 3. NAVIGATING BRIDGE.

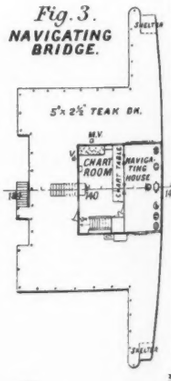
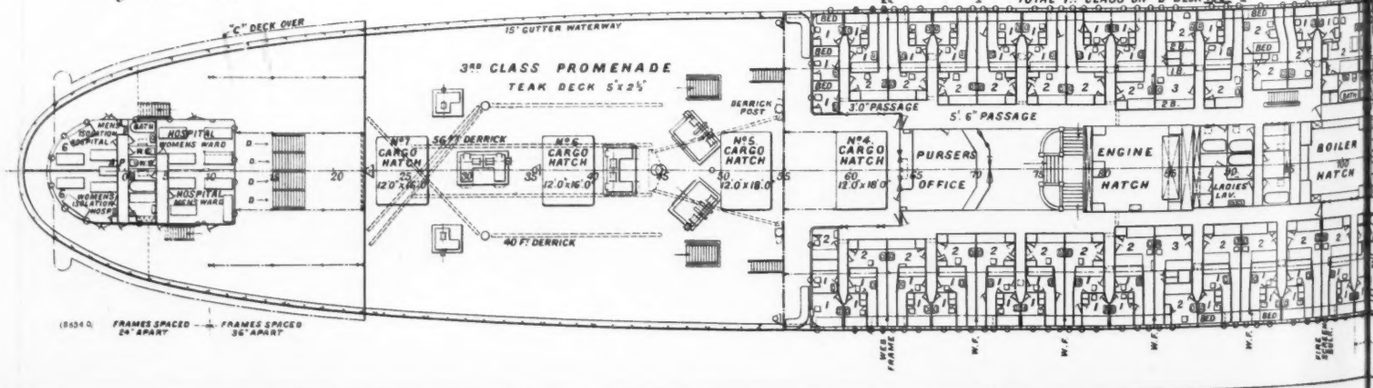


Fig. 5. "D" DECK.

60-1 BERTH CABINS ..... -80
38-2 " " ..... -76
14-2 " (CABINS-DE-LUXE)-28
2-3 " CABINS ..... -6
TOTAL 1ST CLASS ON "D" DECK-130



STEAMSHIP "ORAMA" FOR THE ORIENT LINE

LIMITED, ENGINEERS AND SHIPBUILDERS, BARROW-IN-FURNESS.

(For Description see Page 543.)

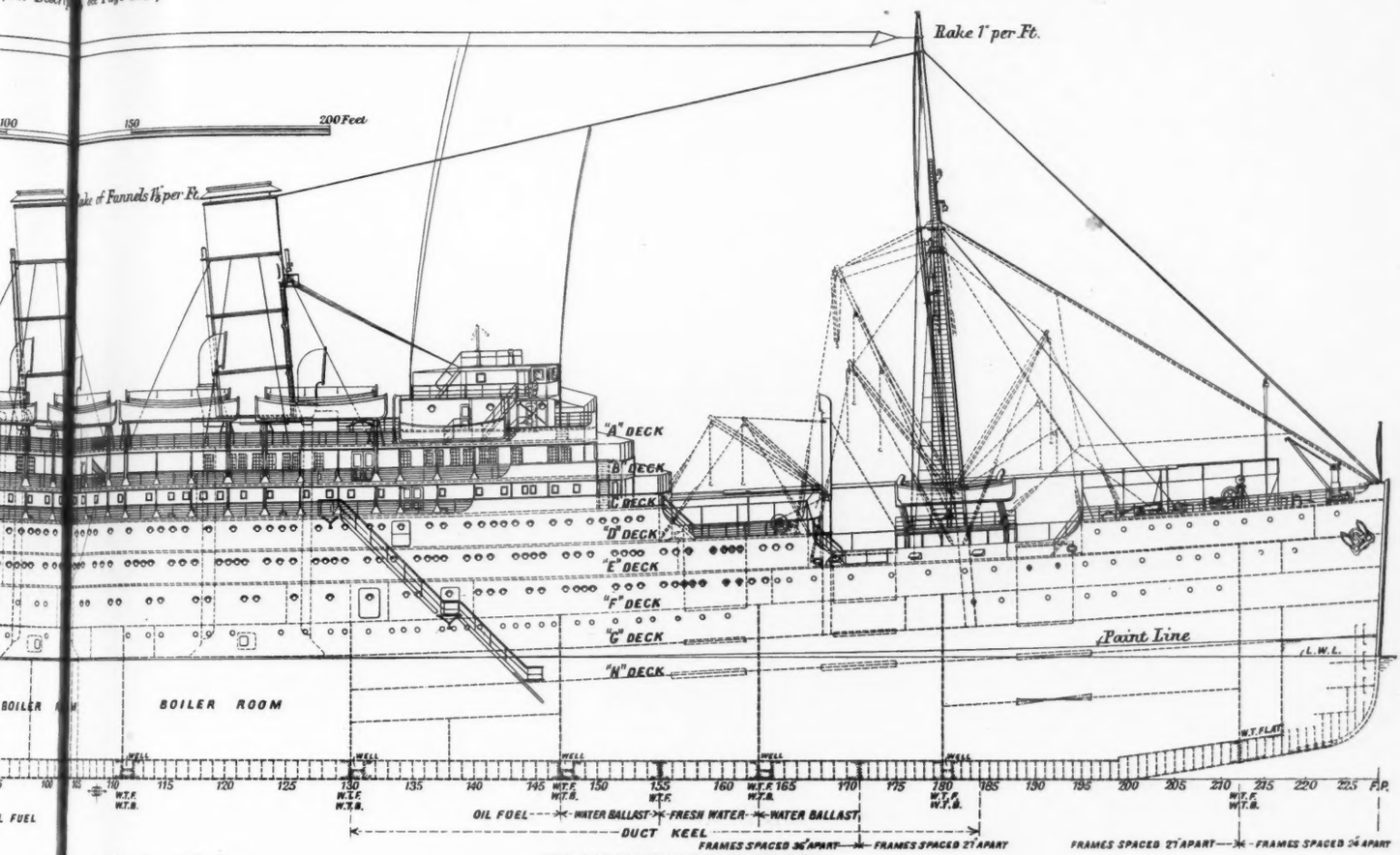
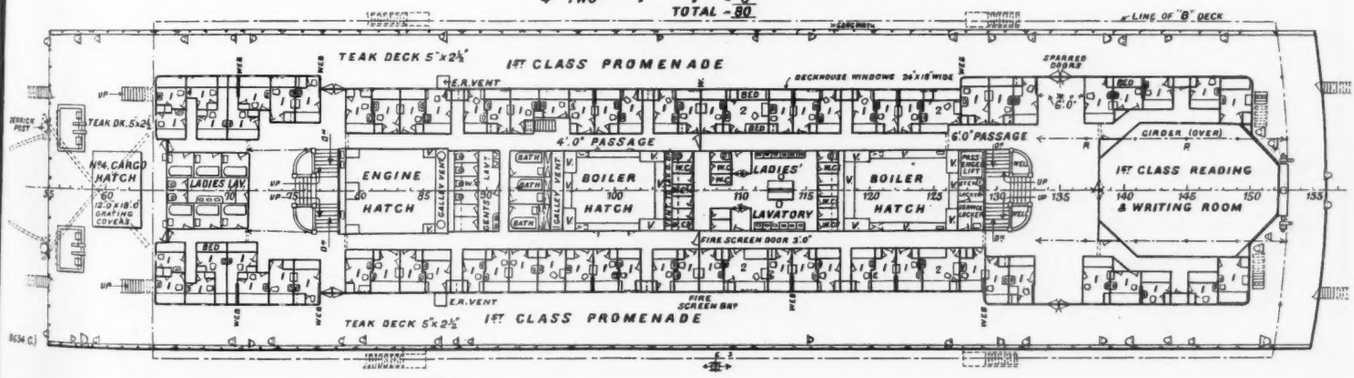
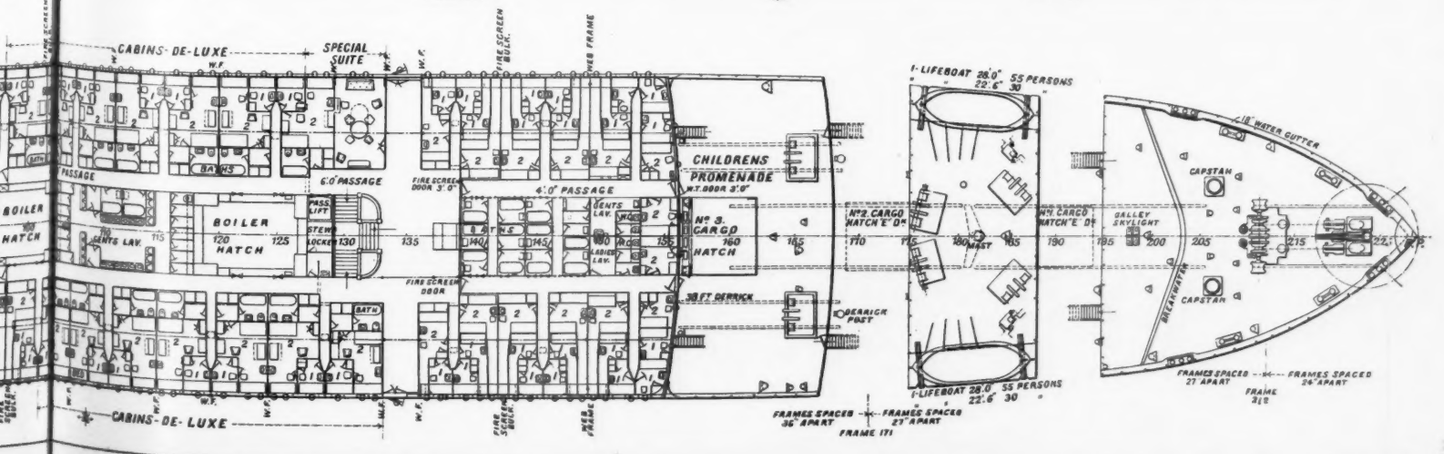


Fig. 4. "C" DECK.

1ST CLASS PASSENGER ACCOMMODATION
72 SINGLE BERTH CABINS - 72
4 TWO " " - 8
TOTAL - 80





TWIN-SCREW GEARED TURBINE STEAMSHIP "

CONSTRUCTED BY MESSRS. VICKERS LIMITED, ENGINEERS AN

(For Description see Page 543.)

Fig. 6. "E" DECK.

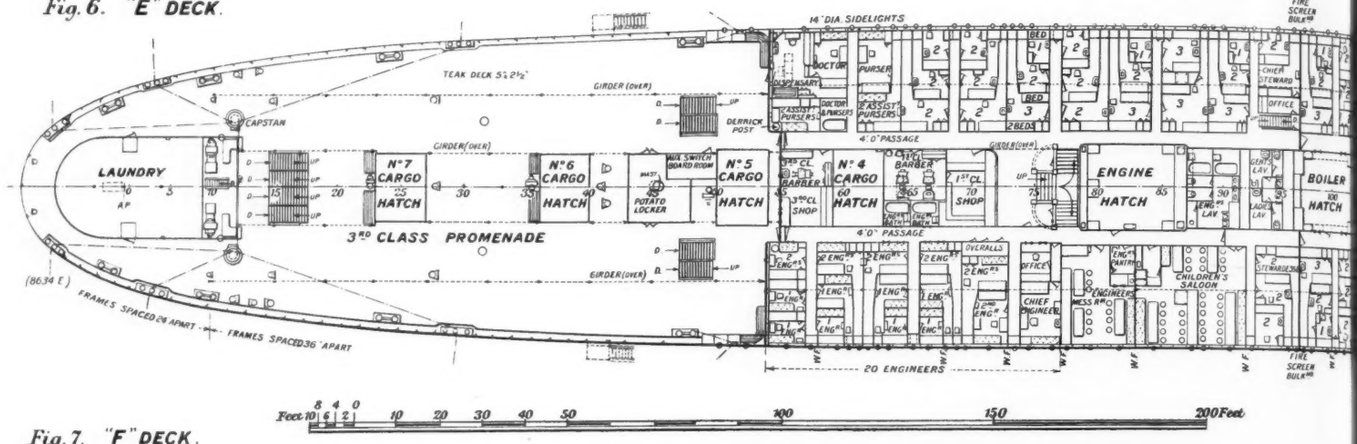


Fig. 7. "F" DECK.

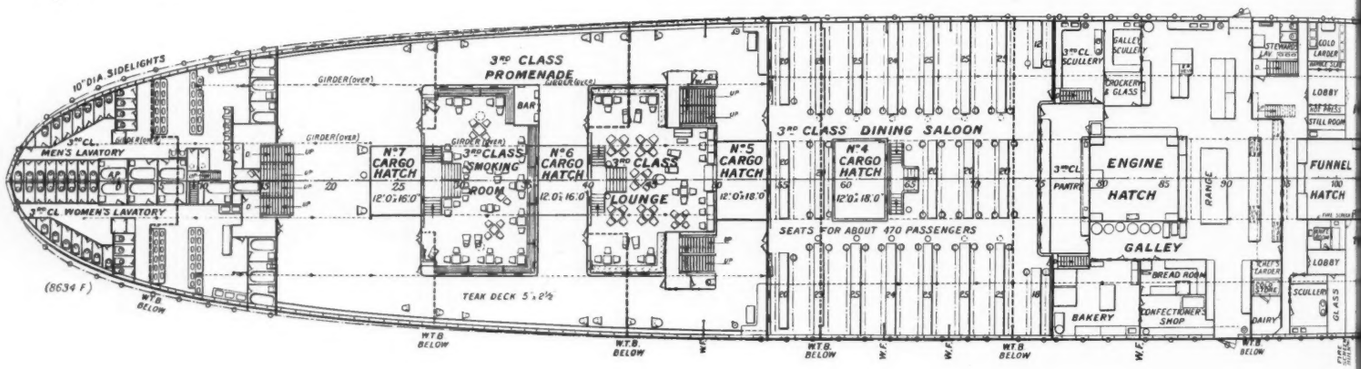


Fig. 8. "G" DECK.

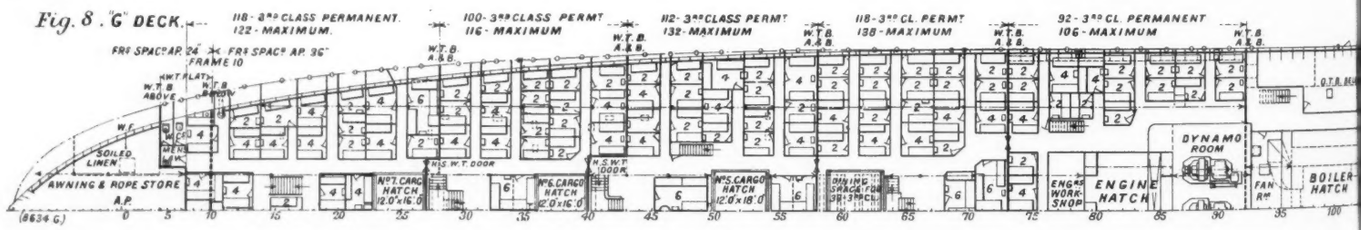

118 - 3RD CLASS PERMANENT. 122 - MAXIMUM.
100 - 3RD CLASS PERM.T 116 - MAXIMUM
112 - 3RD CLASS PERM.T 132 - MAXIMUM
118 - 3RD CL. PERM.T 138 - MAXIMUM
92 - 3RD CL. PERMANENT 106 - MAXIMUM
FRS SPACED AP. 24" FRS SPACED AP. 36"
FRAME 10
AWNING & ROPE STORE
SOILED LINEN
N°7 CARGO HATCH
N°6 CARGO HATCH
N°5 CARGO HATCH
DINING SPACE FOR 98 3RD CL.
ENG.RS WORK-SHOP
ENGINE HATCH
DYNAMO ROOM
FAN RM
BOILER HATCH
W.T.B. A.S.B.
(8634 G)

Fig. 9. "H" DECK.

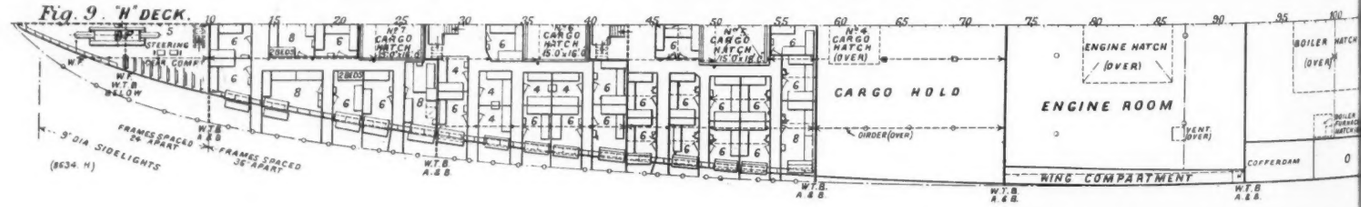
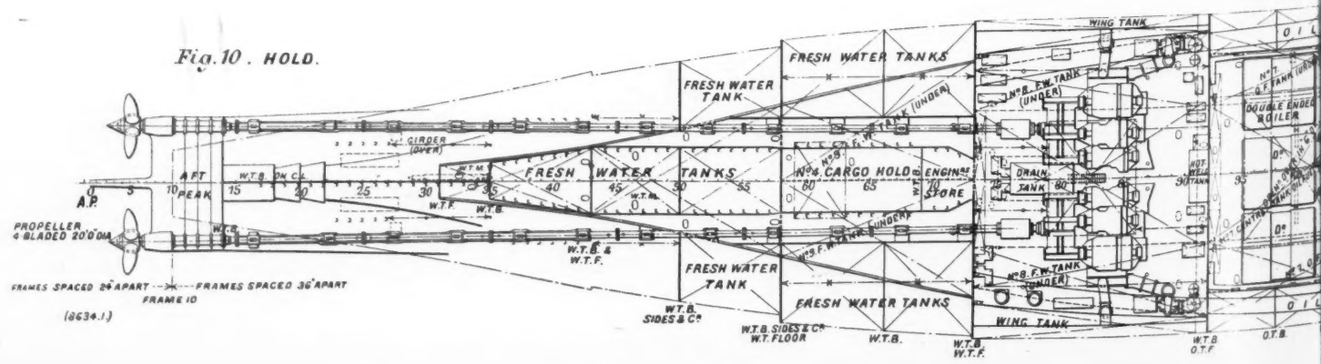


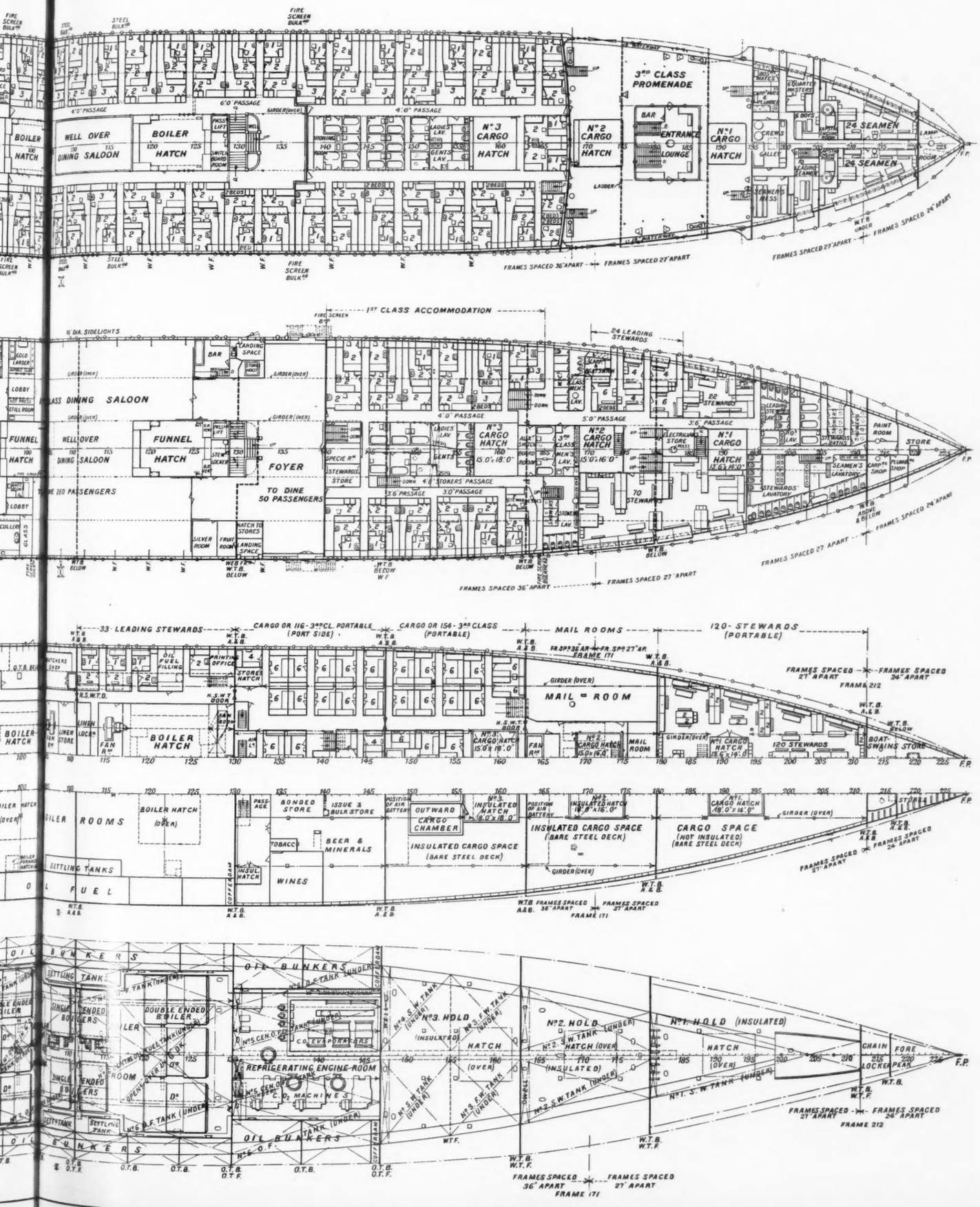
Fig. 10. HOLD.



TEAMSHIP "ORAMA" FOR THE ORIENT LINE.

IMITED, ENGINEERS AND SHIPBUILDERS, BARROW-IN-FURNESS.

r Description Page 543.)



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ENGINEERING.

FRIDAY, OCTOBER 17, 1924.

RESEARCH.

THE word "research" has of late been so greatly abused that it must have required some courage on the part of Dr. W. R. Ormandy to adopt the term for the title of his presidential address to the Institution of Automobile Engineers, which was delivered on Wednesday evening last. Some imperfectly inspired prophet of the Victorian era once declared that science was measurement, and this hopelessly inadequate definition would seem to have been blindly adopted by many laboratory operatives, who often appear to think that, so long as they are measuring something they are necessarily making a valuable contribution to science, and are apt to assume accordingly an irritating air of superiority to the draughtsman and works manager, whose daily activities, in innumerable instances, are far better entitled to be considered research in the best signification of the term than the barren and uninspiring record of measurements to which it is constantly applied.

Perhaps it was some consciousness of a prevalence of this feeling of irritation with the pretensions of "the hodmen of science," which led Dr. Ormandy's choice of a subject for his discourse. We all respect the man who pursues science for its own sake, and of such men we have had some splendid instances amongst our own countrymen. But just as in certain religious communities the standing acquired by the devotion and self-sacrifice of prophets and martyrs has been subsequently exploited by men of ignoble character, so there does seem a danger that men who pursue research as an alternative, say, to the grocery trade, shall attempt to arrogate to themselves halos that belong of right only to a few exceptional personalities. The latter have seldom in the past received an adequate reward for their services to society, and it was probably a realisation of this which led to the establishment of the Nobel prizes, which have done something to redress the inequity. We note, however, that the "researchers'" trade union is opposed in principle to these, influenced possibly by the well-founded conviction of the rank and file of their members, that none of these exceptional awards are likely to fall to their lot.

As matters stand, technical institutions and professional journals are constantly asked to accept lengthy communications describing in minute detail, accompanied by heavy tables, series of measurements which either lead to no practical conclusion, positive or negative, or in other cases are merely repetitions of measurements which have already been made elsewhere. To such communications Professor Armstrong has aptly applied the term research. It is, of course, quite proper that such researches should be made, and indeed in certain laboratories the young student is given the task of confirming, by renewed experiments, results attained by investigators of established reputation. He thus gains facility in laboratory manipulations. Frequently unexpected results are announced, but these can generally be traced to errors on the part of the inexperienced experimenter, who thereby acquires first-hand knowledge of the pitfalls awaiting the unwary.

Much of the "research" work offered to technical institutions and the like constitutes hardly an advance on the foregoing. At other times the investigator frames some hypothesis which, if confirmed, would be of considerable importance. Quite properly, he tests this by experiment, and finds that his provisional theory cannot be reconciled with his observations. A mere announcement of the fact is in that case all that is warranted, but not infrequently he seeks to publish a lengthy detailed description of his abortive investigation.

One class of legitimate "research" has already been commented on; but there is another type which is of fundamental value, viz., the determination of certain important physical constants with extreme precision. This class of work is, however, beyond the capabilities of the ordinary laboratory operative, a certain touch of genius in the experimenter being of greater importance than mere industry and equipment. The most striking instance of the possible importance of such a "research" is, no doubt, the late Lord Rayleigh's re-determination of the density of nitrogen. This was taken up because Regnault had failed to make a certain small correction in his own masterly investigations. The discovery of argon and the whole series of noble gases originated in the circumstance that with certain samples of nitrogen the total weight of gas and container appeared to be 1 part in 1,000 more than with other samples. The actual difference in the weights was only 2·3 milligrammes, a discrepancy which, it is pretty safe to assume, would have been ignored by the average researcher, and probably quite properly, as the average man cannot pretend to a four-figure accuracy in highly delicate experiments.

It was, no doubt, corresponding results—*e.g.*, Joule's conclusion, that heat had a mechanical equivalent, depended on the measurement of temperature differences so small that they could only be expressed in hundredths of a degree—that led to the inadequate definition of science to which reference has already been made. It would be more correct to say that science consists of hypotheses supported by measurement, and unless re-measurements disclose either large differences from their predecessors, or possible minute but well confirmed discrepancies with current hypotheses, they are of but limited interest and value. It is the failure on the part of the ordinary run of experimenter to realise this which is causing a certain revulsion of feeling against industrial research, and it is well, therefore, that Dr. Ormandy should draw attention to the fact that laboratory investigations have cleared up many obscure points in the behaviour of internal-combustion engines. It had long been common knowledge that maximum power output is attained with mixtures distinctly richer than that necessary for complete combustion and that the engine is more flexible when worked

with such mixtures. Messrs. Tizard and Pye have, Dr. Ormandy stated, been recently able to correlate this with the increase in the specific heat of gases with rise in temperature and the dissociation of certain of the products of combustion. They have, moreover, he stated, established the fact that all the usual fuels are practically alike in behaviour. None of them will burn if the mixture is more than 20 per cent. weaker than the "theoretical" mixture, and with richer mixtures the power output follows the same law with all these fuels. It further appears that high compressions give rather a higher increase of efficiency than would be estimated from the air standard, and, moreover, fuels differ greatly in their power of withstanding high compressions without detonating. The alcohols are much superior to the petrols in this respect. It is, however, very curious and interesting, as showing how little we really know about the mechanism of combustion, that the tendency of the petrols to detonate can be reduced by small admixtures of certain other bodies. The reason is still to seek.

Dr. Ormandy perhaps rather over-emphasised the utilitarian value of research in pure science. Such researches have more than sufficient justification, in that they satisfy our innate curiosity as to the nature of the wonderful world in which we live. That they so frequently lead to improvements in the amenities of existence is to be regarded rather as a lucky bonus, rather than as any weighty argument for the encouragement of such pursuits.

Industrial research, quite properly, is, of course, inspired by other motives, and it has undoubtedly some striking successes to its credit, in addition to innumerable minor improvements in trade processes. The drawn wire lamp was, for example, developed in the laboratories of the General Electric Company of America, and in pre-war times German makers of refractories were, as the result of laboratory research, producing very high qualities of fire bricks and furnace linings from somewhat indifferent raw materials. In the very nature of things, however, most industrial research work must be of a somewhat humdrum character, requiring for its pursuit no higher qualities than are needed by the draughtsmen or works manager.

TRANSPORTATION HANDICAPS TO TRADE.

The question of road improvements is too often discussed as if the whole object of good roads was to permit the safe and comfortable passage of motor-vehicles at high speeds. Attention has been concentrated on the provision of smooth and dustless surfaces, the widening of narrow places, the elimination of dangerous corners and other matters highly important to motor-car drivers, but by no means the only ones to be considered. The general principle that roads should be constructed in a manner suitable for the traffic they have to carry, must not be interpreted only in the interests of the users of fast-moving motor cars, charabancs and motor lorries. Adequate roads are as essential to the trade of the country as to its recreations, and it is fully time that steps should be taken to remove the handicap upon our manufacturers which the present state of affairs imposes. Many pieces of machinery are now so large and heavy that the railway companies are either unable to take them at all, or charge such high rates that railway transportation is commercially prohibitive. In such cases, unless the roads are fit to carry the load, the manufacturer has no option but to decline the order. His work-people are thus deprived of earnings, his potential customer has to put up with a less desirable machine, and last, but not least, his ability to keep pace with the developments of his foreign competitors is definitely at an end.

It is in connection with the transport of electrical machinery that the limitations of our railways and roads are becoming specially apparent. Shipbuilders and marine engineers may have to handle larger or heavier single pieces of machinery, but such firms, in the nature of things do not require land transportation for any distance. Our heavy electrical firms are mostly inland, and even if they were not, their products have to be carried to inland power stations, as well as to shipping ports. Modern electrical practice calls for single pieces weighing from 50 to 80 tons or more, and of larger dimensions than the railway loading gauge will pass. It is out of the question to increase the railway loading gauge throughout the country at the present time, but the Ministry of Transport might very well take such steps as would ensure safe road transit for large and heavy weights between the main towns of Great Britain. So far as injury to road surfaces is concerned, it would be reasonable to insist that only approved types of vehicles should be used, with caterpillar tracks if necessary, so as to give the fullest distribution of weight on the ground. Hauliers of exceptional loads should be held responsible for damage caused to road surfaces and should be restricted to routes and hours of travelling, but as a set-off against this control, they should be provided with a definite route between all large towns on a road of such a nature that they could traverse it safely with their loads.

The inadequacy of our internal transport facilities has been demonstrated a good many times recently, and complaints on this score are certain to become more frequent in the future. Some of the exhibitors at Wembley could, no doubt, tell stories of their difficulties in getting material from their works to London, and must be contemplating its return with little enthusiasm. The Transverter of the English Electric Company, which forms so prominent an exhibit in the Palace of Engineering, was hauled from Preston to the outskirts of London, a matter of something like 200 miles by road, because the railway was unable to carry it. Then, we understand, further road transport became impossible, and the last few miles of the journey had to be made by rail. The trouble and expense of this transhipment must have been very great, but under the existing state of affairs, no other course was possible. Furthermore, what difficulties and delays the makers met with in so long a road journey with a load weighing, we believe, over 60 tons may be left to the imagination of those who have had similar tasks to perform.

Public attention has recently been called to the question of road transport by the haulage of the stator of a 20,000 kv.a. turbo-alternator from the works of the General Electric Company at Witton to the Marylebone Power Station. A machine of this size cannot be called an especially large one, in view of modern power station practice, and if electrical development proceeds as we hope it will, dozens of machines as large, or larger, should be installed within the next few years. The stator weighed 62 tons and occupied a space 12 ft. square by 11 ft. 2 in. high. A 50-ton stator, by the same manufacturers, had been carried by rail from Birmingham to Manchester for shipment to Australia some months before, but no railway between Birmingham and London could transport the larger stator, so that there was no alternative to sending it by road. The distance is 113 miles by rail and considerably more by road, particularly as a route had to be selected along which such a load could be taken with the least danger. The job was undertaken by Messrs. H. Bentley and Co., Limited, of Halifax, who make a speciality of heavy and difficult haulage work, and after a ten-days' journey, the machine was safely deposited at the power station.

The fact that it did arrive, must not, however, be taken as evidence that our roads are adequate for the passage of large stators of the kind in question. It is more truly a tribute to the engineering and diplomatic skill of the haulage contractor. The stator was carried on a truck having two four-wheeled bogies, the gross weight being 75 tons. The leading bogie-wheels were 2-ft. diameter, and the trailing wheels 2-ft. 9-in. diameter. The smaller wheels permitted the bogie to swivel through a right angle underneath the platform of the truck. All wheels were 12 in. wide and so arranged that each track was 2 ft. wide. Two traction engines were normally employed for haulage while a third engine, which usually had to bring along the coal truck, was available on the hills. The stator on its truck required 15 ft. head room, and in one case a bridge over the road did not give sufficient clearance. The local borough surveyor refused permission for the road to be cut away for a few yards under the bridge, although the General Electric Company offered to make it good again immediately. Another route had, therefore, to be taken.

Wherever the surface of the road seemed to require it, or where there were underground mains, steel plates were laid down for the wheels to travel over, thus protecting the road and distributing the weight. It is fortunate that no bridges appear to have been injured by the passage of the load, although many of them must have been nominally restricted to the use of much lighter loads. After such a test, it is possible that permissible loads on certain of the bridges might be safely increased with a view to facilitating the movement of other heavy weights. We understand that the haulage contractors had their names taken by nearly every local authority on the route, for exceeding the permissible limits of weight on the roads, but the stator had to be moved somehow, and as the railways could not carry it, the roads had to. It is to be hoped that the whole incident will serve to emphasise the importance of road transport to our industrial development, and bring about conditions under which the carriage of a 62-ton stator will be a less heroic undertaking.

NATIONAL COAL RESOURCES.

In pursuance of its intention to provide a survey of national coal resources the Fuel Research Board has now published particulars of the Arley seam in the Lancashire coalfield.* The work included in this report has been carried out under the supervision of a committee formed by an association of colliery companies—the Lancashire and Cheshire Coal Research Association—with a representative of the Fuel Research Board and another of the Geological Survey. That this considerable enterprise should have been undertaken under the auspices of so essentially practical a body is a matter of some significance to the probable practical value of the work. It is well known that even in the same seam coal will display considerable variations in composition, and those who use it might be apt to doubt whether in fact the variations may not be so wide as to deprive a systematic record of them of any industrial value. The readiness, however, with which a body whose interest in coal is predominantly commercial has undertaken the lengthy work in question warrants at least that, in the opinion of persons exceptionally familiar with its subject matter and acquainted particularly with the occurrence of the coal in the seam in question, the work is likely to lead to results of practical value, by which the various constituents of a seam may be used severally for the purpose for which they are most fit. A similar committee has been formed recently in the South Yorkshire district, and others are likely to be started elsewhere in the near future.

The Arley seam, with which this report is concerned, extends practically from one end to the other of the Lancashire coalfield, over a length as the crow flies of somewhere about 40 miles, and, of course, is much longer when measured along the seam itself. It is of an average thickness of 3 to 4 ft. with local increases up to 6 ft. In the Lancashire coal trade it has the reputation of being singularly consistent in its composition, and indeed for the most part its name is accepted as a sufficient trade description of the coal. The results under notice show for the most part that this reputation is justified, when average samples are considered. Considerable differences, however, are found to exist even locally when the seam is examined at various distances from floor to roof. In a section, for instance, in the Atherton district, from which samples were taken at intervals in height of about 6 in., the average ash was 2·75 for the whole seam, but varied from 7·46 to 0·69 at different levels, the middle part being the lowest. In samples from the Bickershaw district, with an average ash of 3·94 for the whole seam, four sections varied from 5·77 at the top to 2·01 in the middle. In

* Physical and Chemical Survey of the National Coal Resources. No. 3: The Lancashire Coalfield: The Arley Seam. H.M. Stationery Office. [Price 2s. 6d. net.]

both these instances, as in others that were recorded, the ash was much higher at the top than elsewhere, and in the Bickershaw samples the top section contained considerable quantities of pyrites, which were not found lower down. It will be remembered that in other investigations the sulphur contents of a coal seam have been found to be localised in bands an inch or two deep, and a seam that previously could not be used for making metallurgical coke became quite satisfactory for that purpose when the sulphurous part of the deposit had been removed. It would incidentally be interesting to know in what way it has been found convenient to make the separation in practice. Elsewhere, too, localised occurences of phosphorus have been met and dealt with successfully in a similar fashion.

A number of tests were made of the results of low-temperature carbonisation both by assay at 600 deg. C. in the Gray-King apparatus and by carbonisation in lots of about 100 lb. each in the Station's mild-steel horizontal retorts, a description of which has already appeared in these columns (August 10, 1923, page 169). So far as they go, the results of these trials show the same sort of concordance between the small and large-scale carbonisations as has been observed previously, though the amount of material only allowed the large-scale experiment to be made on a sample representing the whole seam. The variations of coking capacity in different sections and in samples from different localities were also observed, and photographs of some of them are reproduced. The report contains also an account of the results of steaming this coal in vertical retorts, which have already been described more fully in a previous report of the Board (ENGINEERING, November 2, 1923, page 565). A special experiment showed that the Arley coal glowed in oxygen under standard conditions at a lower temperature than any of the other Lancashire coals examined. Experiments on the force and persistence of explosions produced by the dust from various coals showed that, although Arley coal is slow in combustion and "gob" fires are almost unknown with it, explosions produced with it are particularly violent, and do not seem to be mitigated by the use of stone dust.

An entirely separate examination of the seam has been made in the Lomax Palæobotanical laboratories by the microscopical methods that have been developed there. These methods involve cutting sections of the coal so thin that they can be viewed by transmitted light; and a complete microscopical examination has been made of the Arley seam from two different localities by horizontal and vertical sections taken layer by layer from floor to roof. These sections are too numerous to be included in the report, but they are filed in the Research Department's Records Bureau, and are available for examination by interested persons. The method is ancient, going back nearly one hundred years, but it is only recently, through the remarkable manipulative skill of the Messrs. Lomax, that serious practical application has been made of it. Some experience tends to show that it may be a useful method of predicting the general character of a seam.

As a whole, the results indicate that the Arley seam is particularly valuable for gas making, though it may also be used for steam-raising, metallurgical and general purposes. Carbonised at 600 deg. C. all samples gave satisfactory yields of tar, gas, &c. but while from some districts the coke produced at that temperature was strong and hard, that from others required to be blended with a seam of inferior caking properties.

THE MOTOR EXHIBITION AT OLYMPIA.

In common with most other branches of engineering industry, the firms engaged upon the manufacture of motor vehicles have passed through a period of severe depression since we had occasion to comment on the last exhibition at Olympia. It is somewhat early to draw conclusions as to the effect of the removal of the McKenna duties, but the most advanced free trader is unlikely to quarrel with the conclusion that their removal must aggravate depression in the first instance. In view of these circumstances it is not remarkable that there should have been a steady fall in prices, and this can only have been borne by the most careful attention to the various methods of increasing efficiency in production.

The continued high taxation on cars may have assisted the industry in that it has to a great extent eliminated the competition of American firms who specialise in low-priced cars equipped with relatively large-bore engines. On the other hand, it must have had a marked effect in restricting the sale of cars to persons of limited means, and it seems unlikely that the very low ratio of cars to inhabitants in the British Isles will appreciably improve until the tax is lowered. When the tax was first increased to its present value a concession was made to owners of vehicles of which the engine was manufactured prior to January 1, 1913. The car was thus subject to this concession in 1920 if the engine was seven or more years old, but by fixing the date of manufacture instead of the age of the car as the basis on which the concession was made, the privilege is rapidly ceasing to become operative.

At first sight this appears to be an advantage to the manufacturer on the grounds that the continued use of an old car delays the purchase of a new one. Generally speaking, however, it will be found that such cars are used by people who could not meet the first cost of a new vehicle, but are able to pay for the comparatively heavy upkeep of an old one out of current income. The older cars in use must thus be a lucrative source of profit to the repairer, but the manufacturer also directly profits by the sale of spare parts.

The growth of the industry has been exceedingly rapid, and it is only comparatively recently that there has been any consensus of opinion amongst manufacturers as to the broad lines to be followed in designing a vehicle for any particular class of service. A general similarity of ideas amongst the leading makers as to the location of the main components was observable for many years prior to the war, and this agreement frequently extended to many of the minor details of construction. After the Armistice there was a marked recrudescence of unconventional designs; and while the majority of the firms of older standing adopted a conservative attitude, many new firms entering the industry attempted to incorporate features inspired by the intensive aircraft development of the war period, such, for example, as radial engines. As might have been anticipated, the last five years have shown that the conservative policy of the older firms was amply justified, and developments in design based on aircraft experience have for the most part been of a minor nature. They have chiefly taken the form of improvements in manufacturing processes, and in the materials of construction.

It is improbable that any fundamental change in either engine or transmission will take place for some time to come, at any rate as regards the touring vehicles such as shown at the Exhibition. The matter stands on a somewhat different footing as regards commercial vehicles, where a strong case may be made out for the introduction of a low-powered heavy oil engine, and an extended use of electric or other transmission giving greater flexibility than that attained with the step-down gear box. The most striking departures from conventional design are to be seen in the cheaper class of light cars, as it is in such cases that one or other of the characteristics which are now deemed to be essential in a high-class vehicle may reasonably be sacrificed in order to reduce the cost. Some of these cars recall early design in such features as air cooling, unconventional position of the engine, and the use of epicyclic gears.

At the time of the last exhibition we referred to the increasing number of firms who were fitting overhead valve engines and front-wheel brakes, and the only marked feature of the past year has been further development along these lines, together with the adoption, by a number of firms, of low-pressure tyres either as standard equipment, or as an alternative to the high-pressure cord tyre. It is probable that the rapid extension in the use of overhead valves has resulted partly from the Treasury method of taxation on cylinder bore. Given two engines of equal power at normal speeds, one having overhead and the other side-by-side valves, the overhead type will be smaller and therefore lighter; but, on the other hand, it will be more expensive to make and more costly in upkeep, as its special characteristics will result in more rapid wear. It will also tend to become noisy more rapidly than the side-by-side valve engine, owing to the greater number of wearing parts, the difficulty of ensuring adequate lubrication to the overhead gear, and the unfavourable position of the latter from the point of view of blanketing the sound produced.

Under the present method of taxation, there is undoubtedly a very large demand for cars fitted with engines coming under the 10-h.p. rating, and a number of makers have specialised in an endeavour to meet this demand. There is practically no sale for a car in this class without a dickey seat, and the general demand is for a double dickey, so that the maker has to provide sufficient power for a load of four persons. Unless such small engines are made with exceptional care and from the highest grade materials, they rapidly fall off in efficiency, and what is even more important, the wear is so rapid that the engines become objectionably noisy after a relatively short period of service. It is no uncommon thing for one of these cars to become noisier after three years running than many of the cars having engines of 12 or 14 h.p. rating after six or more years' service.

Light cars in the past have been fitted almost exclusively with side-by-side valve engines, which are frequently called upon to run for considerable periods under loads which call for almost their full power output, and it is not surprising that under these circumstances they soon become noisy. There is a very natural tendency amongst makers to decrease the engine weight by fitting overhead valves, but it is doubtful whether the improvement obtained by this means over the present side-by-side valve engines will compensate for the greater tendency to become noisy inherent in the overhead valve design. Many of the side-by-side valve engines we have referred to are already highly efficient. We are rather of opinion that every endeavour should be made to persuade customers to consent to a somewhat larger engine, and that this is quite possible is shown by the phenomenal success of one of the firms marketing a car in this class with such an engine.

When commenting upon the War Office Specification for Subsidy Type Light Lorries, we expressed the opinion that a considerable further extension of front-wheel braking was desirable, and we incline to the opinion that legislation should be introduced to make front-wheel braking compulsory on all cars. The rapid increase in the number of motor accidents which result either in fatalities or serious bodily injury is a matter of national concern, and any measure that can be proved to be for the greater safety of the public should receive the support of all manufacturers. There can be no serious doubt that front-wheel brakes fall within this category, as they add about 40 per cent. to the braking power of the car, and thus very appreciably reduce the distance in which the vehicle can be brought to rest. It is desirable that all four brakes should be operated by the foot pedal, as the depression of this pedal in an emergency is quite automatic, whereas a conscious effort is almost invariably required to bring the handbrake into operation. Many accidents result from the failure of the driver to apply the handbrake instantly in an emergency, and even without front-wheel brakes it would be advantageous if the foot pedal brought into action the full braking power available.

If the foot brake alone was capable of locking the wheels no advantage would accrue from coupling it up to the hand brake in addition, but it is common practice to couple the foot pedal to the transmission brake, and after a few months' service this brake is liable to become relatively ineffective.

Turning now to the consideration of modern design in rather more detail, there is an increasing tendency to adopt unit construction for engine and gear box, particularly in the lighter classes of vehicles. This practice has undoubtedly much to commend it, as it eliminates two universal joints between the engine and gear box, but careful

attention to the design is necessary if the clutch is to be reasonably accessible. Several models in the past have been very faulty in this respect. The practice of incorporating the gear box in the back axle unit overcomes this difficulty, but increases the unsprung weight on the back axle. This is not a point of great importance in the case of the smaller cars, and at least one of the leading firms utilises this construction for their smallest model.

A point on which there is marked difference of opinion on the part of manufacturers is that of the anchorage necessary for the back axle. Several makers in recent years have marketed models in which neither torque tubes nor radius rods are fitted, the rear springs serving to take up the torque of both the propellor shaft and rear axle, at the same time performing the function of radius rods. This introduces a marked simplification into the design, but in such a case the entire safety of the vehicle depends upon the strength of the top, or anchoring leaf, of the spring. The rear springs of a vehicle very rarely break, and we are not aware of any accident that has occurred owing to the failure of this leaf, but the practice appears to contain a needless element of danger. The majority of makers fit a torque tube anchored at the rear of the gear box, and as this can be made to serve all the three purposes already enumerated, the springs can be designed solely from the point of view of their primary duty as shock absorbers.

At the time of our going to press the exhibition has not actually opened, and we must therefore defer discussion of the actual models on exhibit to a later issue. There is one further point in general design to which we might draw attention before closing. Many cars which are relatively noiseless on top gear become excessively noisy on the lower gears, and although attention has recently been drawn to the importance of correct tooth form, the matter does not seem to have received the attention which it merits. Some of the larger cars may be said to be almost mechanically perfect with the exception of this defect, and it should be possible to effect a considerable improvement in the direction of more silent gears.

(To be continued.)

NOTES.

The Training of French Naval Officers.

From the beginning of 1925, all candidates for the corps of French naval officers will be taken from the Ecole Polytechnique. The recent ministerial decree, which gives effect to this, makes a radical change in the method of recruiting naval officers. It has been rendered necessary by the decline in the number of competitors for the entrance examination to the Ecole Navale. The Ecole Polytechnique, is the most famous school of applied mathematics in France. The military engineers, the artillery, the architects and surveyors of the Ponts et Chaussées; the corps of naval constructors and the hydrographic surveyors, all receive their theoretical training in it. Competition for entry is keen; out of every eight candidates only one passes. The new ministerial order is certainly in keeping with the traditions of French naval training. In the eighteenth century the scientific knowledge of French naval officers was spoken of with respect by the rough, ill-educated seamen in the British service. Comment in the French naval press is, however, not very favourable. It is stated, in the first place, that the new order may not be even workable. A large proportion of the candidates who pass into the Ecole Polytechnique resign and seek employment in civil life, if their positions on the final lists do not entitle them to posts in the civil engineers; and decline absolutely to be drafted to the military professions. If the number of candidates for a naval career has decreased it is because the service is not popular; and there is no reason to suppose that a preliminary training in the Ecole Polytechnique will make it so. Also, the French tendency to regard mathematics as the one essential thing in a naval officer's education has come in for severe criticism. It is said to be a fresh manifestation of the national mania for developing intelligence at the cost of everything, character included. The French system of training is unfavourably compared with the British method "The British think that the most important thing in a naval officer is not that he shall have scientific knowledge—although their officers are not as ignorant as has been supposed—but that he shall have a taste for the life; a practical training, and a special character. . . . The British navy is, or at least seems to be, separated from the rest of the country. It gains, and the country loses nothing."

Soviet Patent Laws.

The possessors of an exceptionally sanguine disposition or of an unusually adventurous temperament may be interested in a synopsis of the Soviet patent laws, which has been drawn up by Professor J. Heifetz of Leningrad, and is issued in pamphlet form under the title "Principles of the New Russian Legislation for the Protection of Industrial Property." In it will be found a clear statement of the law as it now exists, but, of course, it is impossible to guarantee that it may not be fundamentally altered in a month's time, or at any other period which the Moscow authorities may choose. As matters stand a patentee is accorded the right to sell and to devise his patent and also to issue licences for the use thereof. Foreign patentees must appoint a representative residing within the jurisdiction of the Soviet Government and must work the patent within the country. Power is reserved to expropriate any patent which the authorities may decide to be useful for state defence or which is considered to be of special importance, and in the absence of voluntary agreement the remuneration awarded will be fixed by a special legislative decision of the Soviet officials. Subject to this, the normal life of a patent is to be fifteen years, and this cannot be extended. Provision is made for the recognition in certain cases of patents ante-dating the establishment of the Soviet Government. The registration of designs and trade marks is also provided for. Existing trade marks have, it is declared, lost their validity by the decree of August 15, 1918, and must be registered anew under a decree made on November 10, 1922, which gives the right to apply for such registration to such foreign firms as the Soviet officials may decide to recognise as legal entities.

Port of London Traffic.

It is gratifying to note that the tonnage entering and clearing from the port of London has now overtaken the pre-War figure. In 1913 the tonnage frequenting the Port was 40,082,282 tons, but the War caused a large reduction, so that the figure for 1919 was only 26,335,191. Matters have steadily improved ever since, and in 1922 the tonnage rose to 39,293,139 tons, and in 1923 to 41,215,062 tons, which, as will be seen, is materially higher than in the last of the pre-War years. Unfortunately, the commercial results have been far from satisfactory, as there was an adverse balance of over a quarter of a million on the year's working, which was in part due to strikes, and in part due to a reduction of dues. The reduction was made in the hope of stimulating trade, but, as matters have turned out, the port charges were thereby reduced below the economic limit and have since had to be raised. The Port rates on goods are now generally the legal maximum. Demands by Somerset House for excess profits not legally due led to expensive litigation, as the case was carried to the House of Lords. Amongst the new works in progress may be mentioned a new 15-acre dock in extension of the Surrey Commercial Docks. This will provide five 400-ft. berths and a communication passage 80 ft. wide between the new dock and the Canada dock. The depth of water as at present provided for will be 27 ft., but the walls are being founded at such a depth as to make possible a subsequent deepening of the dock to 35 ft. It is announced that tenders will shortly be invited for the construction of an 1,150-ft. dry dock at Tilbury. The width is to be 110 ft. and the depth on the blocks 42 ft. 6 in. In the dredging operations of the Authority during the year 3,110,904 cub. yards have been removed from the river. In this way a good navigable channel giving a minimum depth of 27 ft. at low water spring tides has been maintained from the sea up to Tilbury. A new bucket dredger is to be delivered shortly.

THE ARTIFICIAL DRYING OF CROPS.

There could hardly be any greater benefit to British farmers than to render their work less dependent upon weather conditions. A spell of cold wet weather during haymaking or harvest time costs the country an incalculable amount in ruined crops, and the only result of a tedious and expensive harvest is a quantity of sadly damaged hay or corn. It is not surprising therefore that the minds of many people have turned to the possibility of saving crops by artificial drying. The ventilation of improperly dried ricks by means of "chimneys" left during construction or by building in "sheep-cages" at the same time is a very old practice, and suffices usually to prevent dangerous heating of a rick. From this practice naturally grew the idea of blowing air into a central chamber left in the rick and letting it escape through the substance of the rick itself. Mr. Borlase Matthews who has given much attention to the improvement of agricultural methods, exhibited a process of this kind at the Royal Agricultural Show at Newcastle in 1923 and we described his method at the time. Other farmers have worked along more or less similar lines, but as yet there is no reliable information generally available as to the best way of carrying out the drying, and of avoiding the troubles of mould and mildew which are liable to be encountered.

The practical importance of saving crops harvested in bad weather is so great that the Institute of Agricultural Engineering at Oxford, under the directorship of Capt. B. J. Owens, has seriously taken up the question of artificial drying of hay and corn, and a demonstration of the method was given on Tuesday last, October 14, on a farm near Oxford. The present developments are the sequel to experiments carried out by the Ministry of Agriculture in 1923. The system then employed consisted in building the stack round a hollow central structure, into which air at atmospheric temperature was blown by a fan and distributed through every part of the stack. Blowing was continued intermittently, until all the surplus moisture was removed and between the times of blowing a certain amount of natural heating was allowed to take place. To dry a 12-ton stack with an initial moisture content of 55 per cent. took about 90 hours, the cost was prohibitive and the material was almost invariably injured by the formation of mould. The conclusion was arrived at that drying a stack by this means was impracticable when the air had a high percentage of humidity.

In the process now employed, the crop is cut in the ordinary way, and if the weather is fine it is left on the ground until the next day. This saves a good deal of artificial drying, because grass, when cut, contains about 75 per cent. of moisture, about a third of which will be lost by merely leaving the crop in the field for 24 hours. Should the weather be bad, however, the crop can be carted as soon as cut, even if it is raining at the time. The stack is built in a circular form around a conical frame composed of six 3 in. by 2 in. rafters covered with wire netting. The frames shown at Oxford were about 8 ft. high and about 4 ft. diameter at the base. As the frame becomes submerged by the rising stack a chimney about 4 ft. high is continued upwards from the apex, this being made in the usual way by drawing a sack upwards as rickmaking proceeds. The top of the chimney is closed by brushwood and the stack continued solid to its finished height. A duct of steel pipe connects the base of the central chamber with the outside of the stack. To this duct a fan is connected by a flexible canvas pipe. The fan takes its air from a sheet iron tank, about 4 ft. cube in size, through which passes a pair of zig-zagged flues lined with firebrick. At the inlet ends of each flue is a burner, burning oil under pressure. The air in its passage through the tank is raised to a temperature from 30 deg. F. to 60 deg. F. above that of the surrounding atmosphere by contact with the heated flues. Blowing with the heated air is begun as soon as the stack is finished, and for a stack containing from 20 to 25 tons would continue for eight hours or so. The rapid removal of the moisture prevents any heating of the stack

THE ARTIFICIAL DRYING OF CROPS AT OXFORD.

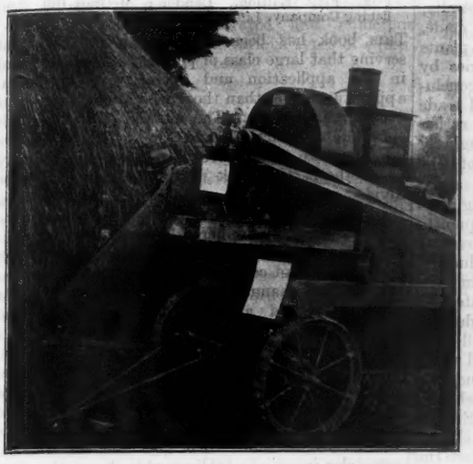


Fig. 1.

Fig. 2.

by fermentation, and it is said to be found by experiment that artificially dried crops are as palatable as those dried naturally and are equally nutritive. Indeed in a bad season it is claimed that artificial hay is better than that made by ordinary methods.

The whole of the apparatus required for drying a rick is estimated to cost not more than 50*l.*, exclusive of the tractor or other prime mover for driving the fan. To dry a 20-ton haystack or 30-ton corn stack is found to require 5,000 cub. ft. of air per minute at 50 deg. F. above the atmospheric temperature. The air is delivered at a pressure of 2·5 in. water gauge, and the work is done in about 8 hours, the power taken being 6·5 brake horse-power and the fuel cost being about 15*d.* per hour. The fan and heater are mounted on a small truck and the fan driven by belt from the tractor pulley (Fig. 1). Several corn ricks containing from 10 to 20 tons each have been dried this year on the Gloucestershire farm of Professor W. Somerville, of Oxford University. These stacks were composed of corn crops containing much clover, the wetness of the season causing the clover to exceed the growth of the cereals in some cases, and the total moisture content to range from 50 per cent. to 80 per cent. The conditions were such that the crops could not have been saved by ordinary methods, but artificial drying proved quite satisfactory.

At the demonstration to which we have referred six different stacks were shown, some of which were in process of drying and others had holes cut in them so that the interiors could be examined. One of the latter showed signs of mould, but this was explained as being due to moisture rising from the base, which was built on a layer of straw laid direct on the ground. A rick of barley straw, which had been thrashed fourteen days after artificial drying, was also to be seen. It was said to have yielded a bright, hard sample of grain, which fetched the maximum market price, but some of the straw still carried grain, a fact which may have been the fault of the thrasher or may have been due to an undesirable toughness remaining in part of the straw. The most spectacular exhibit was a small stack of lucerne and rough grass being dried. The stuff was about as wet and green as it could be, and the smell of the air coming from the rick was like that of a wet retriever dog. Left to itself the rick would probably have taken fire in a few days, but perfectly satisfactory results were anticipated from previous experience. Fig. 2 shows this rick being dried, and the state of the material may be judged from the steam rising from the rick.

The impression which, we think, must have been made on most of those who witnessed the demonstration was that the process was a perfectly practical one, but that the ordinary farmer would want a good deal of experience before he could be sure of getting proper results. The making of a rick, especially with wet material, in such a way as to ensure the passage of the air uniformly through it, the correct quantity and temperature of the air required to dry the rick without spoiling the germinating qualities of any seed or grain in it, and other matters are all essential to success, and the great difficulty appeared to be for a farmer to know that he was doing the job properly. The work, in our opinion, is of the greatest practical importance, and the investigation should certainly be continued until it is possible to put the apparatus in the hands of an ordinary agricultural worker with the assurance that if he makes his rick according to instructions and blows for so long at a given temperature, he will get the results desired. It may be that a simple moisture gauge, capable of being thrust into any part of a rick, must be devised, to know when the rick is "done," and possibly some means must be provided of controlling the air supply to any particular portion of the rick, so as to get uniform drying, but the matter should not be let drop until its possibilities are fully investigated. The Institute of Agricultural Engineering will have more than justified its existence if it will settle once for all the question of the practicability of drying crops artificially in seasons when Nature declines her services.

LITERATURE.

Is Unemployment Inevitable? An Analysis and a Forecast. Macmillan and Co. London: 1924. [Price 8*s.* 6*d.*]

Those who remember or profited by the comprehensive review published last year on the economical condition of the country, entitled "The Third Winter of Unemployment," will welcome another closely reasoned contribution on another phase of the same topic. The same unofficial committee, under the guidance of Mr. W. T. Layton, with the collaboration of several acknowledged authorities, discuss the causes that have been suggested to explain the depressed condition of commerce and industry and the remedies, or some of them, proposed to remove the disabilities that hamper the renewal of trade. Needless to say, that in a matter of such complexity the committee do not expect their views to be accepted in their entirety. Effects have been mistaken for causes, judgment too often warped by self-interest or prejudice, and misrepresentation employed as a weapon of attack, to permit an unqualified assent to the conclusions. The object is rather to supply material for thoughtful discussion, to give facts in the place of conjecture, and to indicate the logical conclusions that follow from the facts established by impartial inquiry.

Whatever opinion may have been formed of the causes of the economic dislocation from which we are suffering, the attentive and critical examination of facts and deductions cannot but be of advantage. If we differ from authoritative teaching we have to find firm grounds for our opposition; if we agree, we are supplied with additional reason for our conclusions. Ignorance or the acceptance of half-truths have much to do with the movement of the wave-like swings that interrupt the uniform progress of the business world. The origin and maintenance of these fluctuations, known as trade cycles, may sometimes be traced to the operation of the unreasoning and recurring alternate flow of optimism and pessimism, which the spread of more accurate knowledge can do much to mitigate. Professor Marshall taught that "better and more widely diffused knowledge is a remedy for that excessive confidence which causes a violent expansion of credit and rise of prices, as it is also a remedy for that excessive distrust which follows."

The trade cycle and the part it plays in determining the periodic fluctuations of industrial progress figure largely in the programme discussed by the committee. The subject is treated at great length and ability by Professor Pigou, who demonstrates that many factors contribute to the observed result, while the worried sufferer, it may be, sees only one. It is impossible to summarise his long sustained argument, and almost equally difficult to state his conclusions, without doing him an injustice by omitting some of his reservations, or distorting the perspective. We are, however, hardly prepared to attach the importance to psychological influences and crowd instinct as explanatory of the fluctuations of prosperity and distress, or to give the same weight to the effects of errors of optimism and pessimism on which he is inclined to insist. On the other hand, the corrections or palliatives that he suggests as calculated to diminish the amplitude of the swing of the trade pendulum cannot be lightly dismissed, though some seem to be hardly within the range of present politics. The subjects which come under discussion are the problems of price stabilisation, the currency plan of Professor Fisher, and the assistance which central banks might afford in the policy of discounting. Thoroughness is shown in his contemplation, if not advocacy, of the supersession of such institutions as the Bank of England by a system of central banks definitely organised as departments of the Government.

Professor Gustav Cassel addresses himself to the problem of reducing the extent of unemployment, and he sees salvation in promoting the reorganisation of those parts of Europe whose economic life has been disturbed, especially by the instability of monetary standards and the accompanying evils, exaggerated by the adoption of an unwise inter-

national policy. He holds that England has little to fear in financing her most active and aggressive competitor, and that the removal of the burden of internal debt, both State and municipal, which has been practically annihilated by the deliberate adoption of a policy of inflation, will not prove an unmixed advantage to the German manufacturer. Nevertheless, he is constrained to admit that if the solution of the reparations question be of such a character that France gets the reparation payments, and England the artificially increased competition, it certainly seems very difficult indeed to see where the advantage to England comes in. We agree.

Professor Bonn pursues the problem of inflation still further, and concludes that the cost of production will be favourably affected by the wiping out of old debts, but, on the other hand, adversely, by the limited scope of sales at home, by a high rate of interest, and by taxation levied on production. He takes a gloomy view of the immediate future of Germany, pointing out that though manufacturing plant has been renewed on model lines and equipment perfected, she will be unable to work this mechanical plant at full output, as the total number of possible customers is insufficient for the full industrial productive capacity of the world. Professor J. H. Jones does not share these gloomy forebodings so fully as his colleague, but he holds that the virtual disappearance of such fixed charges as debenture interest is likely to prove a severe handicap to British industry, as this will operate as a kind of bounty to the German manufacturer.

Mr. C. K. Hobson investigates the problem of oversea investment, asking how far the problem of home employment is likely to be affected by the export of capital abroad. With the possibility of greatly increased manufacturing activity in Germany on the recovery of her economic freedom, and in the event of German competition exercising an adverse influence on home trade, it seems only too probable that English investors will adopt this method of employing their surplus capital. The question of a possible control over the export of capital by legislative processes becomes of great importance, and Mr. Hobson renders good service by probing this point. He examines at some length the machinery adopted by the Government during the war to prevent the outflow of capital, and concludes that under normal peace conditions any attempt at control would be impracticable. Any organised proceeding is not likely to be effective and would certainly be resisted by the community. "Where a strong motive exists for exporting capital, the experience of Germany and other countries in the last few years shows that it is quite impossible to prevent evasion."

A large and interesting section of the book gives the views of specialists and of competent authorities on the condition of various British industries, but of these it is impossible to give details. Sir A. D. Hall, who enjoys a unique position for surveying the present condition and future prospects of agriculture, offers sound, if somewhat unpalatable advice to the farmer. He counsels him to get down to prairie methods, to aim at a low yield per acre, but a high production per labourer. The outlook for the coal industry as presented by Mr. W. Thorneycroft is not cheerful reading. He discusses impartially the effect on production and prices of safety legislation, the Seven Hours Act, and the Finance Act. He impresses upon us the increasing use of oil fuel and of water power, and the increasing development of coal supplies from other centres. He reminds us that exported coal will be materially reduced as soon as the German output in the Ruhr revives. He faces the difficulties and the unpleasantness of the situation fairly, and does not permit us to deceive ourselves by indulging in flattering hopes. He makes the truth abundantly clear that if the standard of living, now being paid out of capital, is to be maintained by economic and permanent means, increase of production per head is absolutely necessary. Insistence on this obvious fact is too frequently resented, and those who question its evident truth may think to find support in a paper by Mr. H. Jeans, who reminds us that in 1913 our steel ingot output was slightly less than eight million tons per annum, whereas we are now credited with a capacity of 12 million tons, and he pertinently asks: where are we going to find a market for the additional 50 per cent., when Canada, Australia, Japan, Italy, Spain, India and China have made, and are making, important additions to their plants and are strengthening their nascent industries by a tariff wall? He is obliged to come to the conclusion that the outlook for the iron and steel trade is not a rosy one, though, guided by hope rather than experience, he looks forward encouragingly to the future to remove the anxiety of the present.

Mr. Horsfall surveys the condition of the engineering industry, and the thought so frequently emphasised by his colleagues, that employment and trade cannot get back to full production until the old export markets are reopened and the volume of world trade increased, is repeated in general terms, and with similar force, though with some diversity of detail. The pessimist will raise the objection that with the greater demand there will come a greater number of competitors, and that nations and peoples, who have been taught by years of scarcity that English capital and English workmanship are not indispensable, will change their habits only slowly. It is probable that the first fruits of reawakened energy will fall to the German, whose competition will be quickened by his long-nursed grievance against the English, and he will find the means of accomplishment in the improved equipment he has acquired and the removal of monetary obligations. In describing the woollen and worsted trades, Mr. Shimmin is able to point to some technical achievements, and Professor Daniel's analysis of the outlook for cotton is written in a hopeful vein, but neither conceals the fact that our profitable customers of old are meeting a large proportion of their requirements by their own machinery. In the case of cotton it must be noted with disquietude that the amount spent by consumers is practically fixed, and that consequently when prices are high the quantity required is less. The market remains inelastic, and the remedy is apparently to be found only in greater production of the raw material.

The allied subjects of shipbuilding and port facilities are treated by Professor Jones and Mr. Clement Jones, respectively. The former has no difficulty in submitting evidence of the depression in shipbuilding, but his indications of the prospects of recovery are not equally convincing. He can do no more than point to a distinct possibility of a very rapid recovery, and the qualifying clause, that "it is not more than a possibility" is not cheering. The connection between port facilities and shipbuilding is patent. The possession of adequate docks and harbour accommodation, quays and transit sheds, inland railway transport, &c., may reduce the number of ships required, while their want would only lead to congestion if the number of ships was increased. Mr. Jones' examination of the amount and character of the facilities provided at British ports leads to the conclusion that they are sufficient to deal with a normal increase in traffic during the next 20 years, provided that the port plant is kept in a state of efficiency.

The question "Is Unemployment Inevitable?" concerns the future as much as the present, and the necessity arises of forecasting the numbers that will be required to be fed and employed in the coming years. This is a purely statistical question, complicated by the allowance to be made for emigration, wars and the declining birth-rate. Different authorities give different answers according to the weight they attach to the variables, and we think Professor Bowley underestimates the number when he assigns a figure of 47,000 as expressing the annual increase in the employed population from 1931 to 1941. He seems to contemplate the possibility of a shortage of labour rather than a surplus, and regards the small numerical increase as a favourable factor in the problem. But as in many cases the obvious is too often the incorrect deduction, and it may well be that with the less need for enterprise to support a growing population, less energy will be expended and as great difficulty be experienced in providing for the smaller number.

Principles of Electric Motors and Control. By Gordon Fox. First Edition. London: McGraw-Hill Publishing Company, Limited. [Price 17s. 6d. net].

This book has been written with the object of serving that large class of people who are interested in the application and operation of electrical apparatus rather than those who are engaged in its actual manufacture. The method of treatment is simple and practical, and the types of motors described are those in regular use in one industry or another. The book may, broadly speaking, be divided into two main sections, the one describing the various types of motors in commercial use at the present time, their inherent characteristics, applicability and performance; the other dealing with the principles of control and the equipment necessary for both manual and automatic operation. As both direct and alternating-current motors and control gear are included it will be seen that a fairly wide field is covered. There are, in addition, chapters on operation of motors in parallel or series, the use of flywheels in the application of electric power and electric motor braking. It is recognised by the author that it is not possible in a single volume to do more than give the fundamental principles involved; bibliographies have, therefore, been included to enable the reader to pursue further any individual line of investigation.

This is an age in which specialisation is becoming very intensified and while it is essential that this should be so in the interests of accurate knowledge and efficient production, yet the average electrical engineer finds it in consequence extremely difficult to obtain a comprehensive knowledge of the industry, as his energies are principally devoted to the particular work in which he is engaged. It is, however, essential if he desires to broaden the basis of his knowledge that he should become familiar with subjects related to his work and it is in such cases that a book of this kind, which brings together a large amount of widely scattered knowledge, is of the greatest help. But, perhaps, the kind of man to whom it would prove of most value is the engineer in charge of industrial plants whose daily work is of a varied character and where a wide knowledge is desirable.

The value of the work would have been increased if more regard had been paid to the relative importance of the various classes of machines and the space allotted to their description. To give an example of this, one would refer to the description of the Ward-Leonard system of control which is disposed of in two pages as contrasted with the ten pages devoted to the Dynamic control of Induction Motors. While it is admitted that the speed control of induction motors by means of auxiliary machinery arranged to introduce a counter-voltage into the secondary circuit is one of considerable technical interest, it should have been borne in mind that the Ward-Leonard System is one of great practical interest and importance owing to its extensive use in the iron and steel and coal mining industries. It is also to be regretted that the reference on page 148 to that useful machine, the Synchronous Induction Motor is so brief and unsatisfactory. Indeed, it is misleading, as this type of machine is now constructed with a direct-current exciter and has been installed for outputs of over 1,000 horse-power.

That section dealing with the principles of control and the equipment required for starting, stopping, protecting and generally controlling the speed and direction of rotation of various types of motors occupies a considerable portion of the book. It is, of course, necessary that the motor be suited in its inherent characteristics to the nature of the load demand. This condition being fulfilled it is of equal importance that the proper control functions be employed to direct the application of motive effort to the greatest advantage. These functions are fully dealt with in two separate chapters, wherein a reference is made to the "Eddystat" which has recently been developed for use in connection with wound-rotor induction motors. This device derives its name from the fact that it dissipates the secondary losses during acceleration in the form of eddy-current losses. These automatically decrease

as the motor speeds up and the controller may, therefore, be left permanently in circuit, thus ensuring constant protection for the machine.

The chapters describing the various types of both manual and magnetically operated starters and controllers are well illustrated and numerous diagrams of connections for various types of equipments are embodied in the text.

The Modern Theory and Practice of Pumping. By Norman Swindon, M.I.Chem.E., A.M.I.Mech.E. London: Ernest Benn, Limited. [Price 42*s.* net.]

This is a really valuable book on pumping problems, though its sub-title appears a little unfortunately worded. In this sub-title the book is described as "A Treatise on the Application of the Reynolds-Stanton Law of Viscous Flow to Modern Pumping Problems, and the Flow of Liquids through Pipes." As a matter of fact the term viscous flow is commonly regarded as applicable to the ordered stream line flow which is observed before the critical velocity is attained. The flow beyond this point is in contra-distinction named turbulent flow. There is thus no Reynolds-Stanton law of viscous flow, since, as the author himself shows, we have had of this a complete mathematical theory dating back to Stokes at least, and thus long prior to Osborne Reynold's researches.

To finish with adverse criticism, it may be added that the author's calculation of the flow between a long-spindle and a closely-fitting gland is not sound. It is not permissible to assimilate the annulus between spindle and gland to a circular pipe of the same hydraulic mean depth. As a matter of fact, if the spindle touches the gland along a line instead of being concentric, the discharge under a given head will be two and a-half times as much as in the concentric position, although the hydraulic mean depth is unaltered. A correct formula for calculating leakages past such spindles was given by Mr. R. B. Domony in a letter published in our issue of May 28, 1915, page 610. For a spindle concentric with the gland it runs as follows :—

$$w = \frac{D\,S^3\,P}{26585\,L\,\mu\,V}$$

where w = weight passed in lbs. per hour;
D = spindle diameter in inches.
S = clearance in mils.
P = pressure difference in lb. per sq. in.
L = length of hole in inches.
V = cubic feet of liquid per lb.-weight.
μ = viscosity in C.G.S. units.

If the spindle and gland touch along a line, the weight passed will be 2½ times the value thus calculated as stated above.

The opening section of the volume is devoted to a discussion of viscosity and should fill a widely-felt want. There are so many different viscometers in use that it is difficult to bear in mind their individual characteristics, and the capitally-illustrated and detailed descriptions given by Mr. Swindon will be most useful for reference purposes. The concluding portion of this section gives a short account of Reynold's fundamental work, and of some of the important experimental verifications which have since been made of it.

Part II of the volume deals in detail with different forms of pumps.

The section on ram pumps is excellent, both in text and illustrations. A good deal of space is given to the special problems met with in chemical works where corrosive fluids have to be pumped, sometimes against considerable heads. For such purposes, however, the author has an evident leaning towards the centrifugal type of pump in view of its simplicity, compactness and absence of valves. After a short discussion of the general theory of these pumps, the author describes many of the variants, and this section will again be very useful for purposes of reference. After describing, in the succeeding chapter, various forms of rotary pumps the author gives a very detailed discussion of both the theory and design of the air lift, which for certain special purposes has advantages which outweigh its low efficiency. The author claims, moreover, that this efficiency can be materially increased by careful design, and to facilitate this there are given in the book a number of ingenious graphs. A chapter on "Miscellaneous Lift Appliances" concludes the volume.

BOOKS RECEIVED.

Diesel and Oil Engineering Handbook. Land and Marine. By Julius Rosbloom. Second enlarged edition. Los Angelos, California: The Technical Publishing Company.

United States Geological Survey. Bulletin No. 690—B. *Gravel Deposits of the Caddo Gap and De Queen Quadrangles, Arkansas.* By H. D. Miser and A. H. Purdue. No. 723. *Geology and Ore Deposits of the Manhattan District, Nevada.* By H. G. Ferguson. [Price 50 cents.] No. 746. *Geologic Literature on North America. 1785–1918. Part I. Bibliography.* By J. M. Nickles. [Price 1 dol. 25 cents.] No. 752. *Coal Resources of the Raton Coal Field, Colfax County, New Mexico.* By W. T. Lee. [Price 50 cents.] No. 754. *The Ruby-Kuskokarin Region, Alaska.* By J. B. Mertie, jun., and G. L. Herrington. [Price 50 cents.] Washington: Government Printing Office.

Steel Construction of Aeroplanes. By Harry Harper. Glasgow: Robert Maclehose and Co., Ltd., University Press (1924). [Price 12*s.* 6*d.* net.]

The University of Missouri. Engineering Experiment Station. Series 23. *Experiments on the Extraction and Recovery of Radium from Typical American Carnotite Ores.* By H. H. Parker. Columbia: University of Missouri.

Die Legierungen in ihrer Anwendung fur Gewerbliche Zwecke. By A. Ledebur. Berlin: M. Krayn. [Price 20 cents.]

Reinforced Concrete Design. By G. P. Mannering, B.Eng. London: Longmans, Green and Co. [Price 21*s.* net.]

Incorporated Swansea Exchange. Thirty-sixth Annual Report. Swansea: Ernest Davies and Co. (1919). [Price 3*s.* 6*d.*]

National Physical Laboratory. Collected Researches. Vol. XVII. 1922. London: His Majesty's Stationery Office. [Price 17*s.* 6*d.* net.]

Is Unemployment Inevitable? : An Analysis and a Forecast (Various Authors). A Continuation of the Investigations Embodied in "The Third Winter of Unemployment." Published in 1923. London: Macmillan and Co., Limited. [Price 8*s.* 6*d.* net.]

United States Bureau of Standards. Circular No. 164. *United States Government Master Specification for Flat Glass for Glazing Purposes.* [Price 5 cents.] Scientific Papers No. 487. *A Quantitative Study of Regeneration by Inductive Feed Back.* By C. B. Jolliffe and Miss J. A. Rodman. [Price 10 cents.] Washington: Government Printing Office.

Marine Structures: Their Deterioration and Preservation. Report of the Committee on Marine Piling Investigations of the Division of Engineering and Industrial Research of the National Research Council. By W. G. Atwood and A. A. Johnson. Washington: National Research Council.

Cadmium: Its Metallurgy, Properties and Uses. By Norman F. Budgeon. London: Charles Griffin and Co., Limited. [Price 21*s.* net.]

Carburation in Theory and Practice: A Manual of Reference for Automobile Engineers and Owners. By Robert W. A. Brewer. London: Crosby, Lockwood and Son. [Price 15*s.* net.]

All the World's Aircraft, 1924. Compiled and edited by C. G. Grey. London: Sampson Low, Marston and Company, Limited. [Price 42*s.* net.]

French-English and English-French Dictionary of Technical and General Terms, Phrases and Abbreviations used in Finance, Banking, Currency, Foreign Exchange and Stock Exchange Transactions, &c. By J. O. Kettridge. London: George Routledge and Sons. Limited. [Price 10*s.* 6*d.* net.]

American Concrete Institute. Proceedings of the Twentieth Annual Convention. Chicago. 1924. *Vol. XX.* Detroit: Offices of the Institute.

United States Bureau of Mines. Bulletin No. 214. *Tests of Marine Boilers.* By H. Kreisinger and others. [Price 55 cents.] Technical Paper No. 317. *Silver in Chloride Volatilisation.* By C. M. Bouton and others. [Price 10 cents.] Washington: Government Printing Office.

United States Geological Survey. Bulletin No. 747. *Geologic Literature on North America* 1785–1918. *Part II. Index.* By John M. Nickles. [Price 65 cents.] Water Supply Paper No. 520—B. *Additional Ground Water Supplies for the City of Enid, Oklahoma.* By R. C. Renick. Washington: Government Printing Office.

Contribution à la Théorie des Moteurs à Combustion Interne. By M. Brutzkus. Paris: Gauthier-Villars et Cie. [Price 8 francs.]

United States Bureau of Standards. Miscellaneous Publications No. 55. *Sixteenth Annual Conference on Weights and Measures, Washington, May,* 1923. [Price 30 cents.] Washington: Government Printing Office.

Aeronautical Research Committee. Reports and Memoranda No. 903. *The Prediction on the Prandtl Theory of the Lift and Drag for Infinite Span from Measurements on Aerofoils of Finite Span.* By A. Fage and H. L. Nixen. [Price 9*d.* net.] No. 908. *Experiments with Rudders on Two Twin-engined Aeroplanes.* By F. W. Meredith. [Price 9*d.* net.] No. 911. *A Generalised Type of Joukowski Aerofoil.* By H. Glauert. [Price 6*d.* net.] London: His Majesty's Stationery Office.

Marine Oil Engine Trials Committee.—A joint meeting of the institutions concerned is to be held at the Institution of Mechanical Engineers, Storey's-gate, at 6 p.m., on Friday, November 21, at which meeting the report prepared by the Marine Oil Engine Trials Committee will be submitted and discussed.

REPAIR OF LA VOULTE CAST-IRON RAILWAY VIADUCT.

The railway line from Livron to Privas crosses the Rhone over a cast-iron viaduct of five arches, each of 180 ft. span. The viaduct is in close proximity to the town of La Voulte, a few miles south of Lyons, and was built in the year 1861. Many cracks developed in the course of time in its various members, owing to the great rigidity of the cast-iron cross connections between the ribs, and the viaduct becoming unsafe, it was allowed to carry a limited traffic only. A scheme was prepared several years ago to replace it by a new bridge of the straight girder type, but this was not given effect to owing to the war. After the war, the building of a new bridge was found to be out of the question, owing to the great cost it would have involved, and a cheaper solution was decided upon which consisted in utilising the existing structure, strengthened by additional steel members and by reinforced concrete.

The repair and strengthening work, which formed the subject of a paper read last Tuesday, by M. de Boulongue, at a meeting of the British Section, of the Société des Ingénieurs Civils de France, was carried out during last year. The members which had become defective and in which cracks had developed, notably the cast-iron cross pieces connecting the arched ribs, were replaced by steel frames. At other parts steel bars and rods were built up and encased in concrete, and, in order to secure satisfactory adhesion between the concrete and the metal surfaces, sandblasting was resorted to. Arc welding was adopted with satisfactory results in the repairs at several portions of the viaduct, for example, in repairing the handrail uprights several of which had split, and would have been difficult to repair by any other process. The raising of the permanent way by about 2 ft. necessitated an equal raising of the footpath, and the original handrail had to be made correspondingly higher; this was done by arc-welding on the top of each upright, an extension piece through which the new handrail runs. All the cracks which existed in the various cast-iron members remaining in the structure were arc-welded on both faces.

The viaduct, as repaired, maintains the general appearance of the original one, and the tests carried out with locomotives of the "Pacific" type, the heaviest type of French engines, have proved entirely satisfactory. With three such engines coupled together, crossing the bridge at a speed of 28 m.p.h., no appreciable vibration was recorded. In this connection it should be remembered that the viaduct is close to La Voulte, before reaching which the trains slow down in the ordinary way. The expenditure involved was 2,000,000 francs.

The main points emphasised during the short discussion which followed the reading of the paper were to the effect that the wedging of the 0·5-in. rods in the voussoirs before connecting was a useful additional precaution, although concrete could generally be relied upon to give a good connection. The setting of the concrete was in no way influenced by the railway traffic during the repair work. The viaduct was lightened before work commenced by the removal of the ballast; it was also lightened somewhat at the springing of the arches and at the crown. The original piers, which were carefully built at the time, were quite able to carry the increase in load due to the repair work described in the paper. Such work as this could only be effected by a staff, every member of which was trustworthy and gave to his particular task unremitting attention and care.

LABOUR NOTES.

The effect on Labour efficiency of the decision of the general half-yearly meeting of the Co-operative Wholesale Society to make membership of a trade union a condition of employment—not only of ordinary employees but also of managers and foremen—is certain to be watched closely by practically everybody interested in industry. The largeness of the minority in each of the two divisions which took place suggests that even amongst co-operators a strong feeling exists that it cannot be conducive to efficiency to have managers, foremen and workers all members of the same trade union. There is, obviously, a good deal to be said for that view, for, as matters are tending, it cannot be easy for a manager or a foreman to be a member of an organisation whose constant endeavour seems to be to make the business of his employers unprofitable. In ordinary industry, managers and foremen are not supposed to be members of the unions to which the men under them belong, and in the great majority of instances they are not. There is, indeed, fairly general and very frank realisation of the fact that the ideal manager or foreman is an intermediary between the employer and his workers—one who holds the balance fairly between the two interests involved, and seeks to utilise the money expended by the

employer in wages in the most profitable way. The practice has been found to work out to the advantage of industry generally, and there is no disposition anywhere, even amongst managers and foremen, to seek a change.

Since 1919, a resolution had been in existence which made membership of a trade union a condition of employment by the C.W.S. It had not, however, been fully complied with, and, owing to dissatisfaction which it had been causing, the directors of the C.W.S. submitted to the general meeting two recommendations. One was that managers, buyers, heads of departments, principal and confidential assistants and employees over 60 years of age should be exempted from the operation of the resolution. The proposal was, however, defeated by 1,562 to 1,531 votes. In view of this decision, the directors then moved that all other employees should join a trade union eligible for admission to the Trades Union Congress, or be dismissed. This was carried by 1,538 to 1,374 votes. From the point of view of efficiency these seem to be unfortunate decisions.

The Central Board of the Shipbuilding Employers' Federation, at its annual meeting in Carlisle on October 10, elected Mr. John Barr, of Barrow, President of the Federation in succession to Mr. Grant Barclay, of Dundee. Mr. Barr has been prominent in the negotiation of both shipbuilding and engineering labour affairs for many years. He has served on the Central Board of the Shipbuilding Employers' Federation, and the Management Committee of the Engineering and Allied Employers' National Federation, and also on the board of the Iron Trade Employers' Association. Mr. J. T. Batey, of Hebburn-on-Tyne, who was junior vice-president, was elected senior vice-president, and Mr. A. J. Campbell, of Dalmuir, was elected junior vice-president in his place. Mr. Campbell is chairman of the Clyde Shipbuilders' Association.

Hull City Council has rescinded its resolution to accept a German tender for rails required by the tramways department. Originally, the Tramways Committee recommended the acceptance of a tender by Messrs. Bolckow, Vaughan and Co., Middlesbrough, but the City Council, including its Labour members, could not see its way to give preference to this tender, which was 3,500*l.* higher over the lowest German tender. The Labour members maintained their former attitude during the discussion, but the motion to rescind the resolution was eventually carried by 26 votes to 25. No tender was accepted.

The Ministry of Labour reports that the number of unemployed persons recorded on the registers of Employment Exchanges in Great Britain on October 6 was 1,215,600—917,900 men, 37,200 boys, 227,600 women and 32,900 girls. On September 29, 1924, the total number of unemployed persons was 1,199,316 and on December 31, 1923, 1,285,623. During the three weeks which ended on October 6 there was an increase in the number of unemployed persons of 51,044.

The October issue of the monthly report of the United Society of Boilermakers and Iron and Steel Shipbuilders states that the number of members "signing the books" at the end of September was 18,706, as compared with 18,062 at the end of August. The expenses for September were 77,326*l.* 11*s.* 8*d.*—a decrease of 288*l.* 0*s.* 8*d.*, as compared with the figures for August.

In September, the membership of the Amalgamated Engineering Union declined from 253,264 to 247,131. The decrease of 6,133 was, however, largely due to a readjustment of the New Zealand figures. The membership, as shown in the branches which existed in New Zealand at the end of 1923, had been carried forward from month to month, Mr. Smethurst explains in the October Journal, until definite information was available as to the number who desired to retain their membership at the General Office. It had now been ascertained that only 420 of the 3,646 indicated in the New Zealand branch returns desired to retain their membership, so that of the decrease of 6,133 in the total figures, only 2,907 related to home branches. "No doubt," the General Secretary adds, "a large number of these have been taken from the books of the union in accordance with the instructions of the E.C. in last month's report." The instructions referred to were, presumably, those relating to the withdrawal of the facilities offered to members in arrears to make good their standing.

The percentage of unemployed members of the Amalgamated Engineering Union was 8·75 at the end of August. At the end of September it was 8·74. The total number of unemployed at the end of August was 20,112; at the end of September it was 19,649. The number of members on sick benefit at the end of September was 4,886, as compared with 4,933 a month earlier, and the number on superannuation benefit 8,833, as compared with 8,744.

It is officially announced that representatives of the executive council of the Amalgamated Engineering Union, in conjunction with delegates from other unions, have met the railway-wagon building and repairing trade employers for a further consideration of the application made in June last for an advance of 10*s.* per week, and also to consider the question of revising working conditions. After a full discussion, the employers' representatives stated that they would report to a full meeting of their association, to which they proposed to recommend that a national agreement be entered into on the question of working conditions. In due course they would submit the conditions they were prepared to recommend, including terms relating to overtime and night shift. On the question of the wages advance, they agreed to give the matter further consideration, and they also promised to see whether a national schedule was practicable relative to the wages of boys and girls.

The local representatives of the Amalgamated Engineering Union and the Border Counties Engineering Employers' Association have reached an agreement on the subject of the wages of young journeymen. It applies to the Carlisle, Kendal and West Cumberland Districts. The wages of young journeymen who have just completed their apprenticeship are to be 10*s.* per week below the full district rate and within one year from the completion of their apprenticeship are to rise to the full district rate by advances of equal amounts every three months. In the opinion of the Organising Delegate, whose headquarters are at Preston, the terms "are a great advance on existing conditions, especially now that the employers in these particular districts will not indenture any boy for a longer apprenticeship than five years."

In pursuance of undertakings given when the Housing (Financial Provisions) Act of 1924 was before the House of Commons, the Minister of Health has taken steps to appoint committees of the building industry and of the manufacturers and suppliers of building materials to advise and assist him in carrying out the scheme embodied in the Act, particularly as regards the development and co-ordination of the supply of labour and materials for house building. The Building Industry Committee has been constituted. Representatives nominated by employers in the industry are Messrs. A. Andrews, J. H. Barker, J. Carse, J. Clark, J. P. Cox, C. E. France, A. J. Forsdike, J. C. Gilchrist, F. G. Hodges, H. T. Holloway, E. W. King, H. Matthews, A. Melville, Wm. H. Nicholls, H. R. Selley, J. Somerville, E. J. Strange, and A. G. White. Representatives nominated by the operatives are Messrs. T. Barron, G. Haines, H. McPherson, D. Merson, S. Sigsworth, G. Waddell, W. Turner, S. Taylor, A. G. Cameron, G. Hicks, W. Coles, R. Wilson, J. F. Armour, W. Cross, and R. Coppock. It is contemplated that representatives of the manufacturers and suppliers of building materials will be added to the Committee. A separate Committee, representative of the manufacturers and suppliers of building materials, is in process of formation, and provision will be made for co-ordinating the committees by means of a small joint committee.

Dangerous encroachments on the eight-hours' day were revealed (says *The Labour Press Service*) by an inquiry instituted by the German Factory Workers' Union. The inquiry covered 320 out of the 481 branch offices of the Union, and dealt with 4,360 concerns, employing 481,449 persons. The result shows, it is stated, that of this number of workers 264,140 (54 per cent.) work up to 48 hours a week, 17,064 (3·6 per cent.), from 48 to 51 hours, 124,592 (26 per cent.), from 51 to 54 hours, and 75,653 (15·9 per cent.) over 54 hours.

The Bulletin, the organ of the Federation of British Industries, reports that the Eight Hours Act is still the object of much discussion in Belgium. The Comité Central Industriel recently passed a resolution urging the Government to make no engagement which, by binding the country for 11 years, would place Belgium at a disadvantage with Germany, where nine and ten hours' work a day is common, and with the United States, where no limit is recognised.

The Governing Body of the International Labour Office is stated to have noted with satisfaction at its recent autumn session at Geneva, the result of the conference at Berne, in September, between M. Thomas and the Labour Ministers of Great Britain, France, Belgium and Germany, on the subject of the Washington Eight Hours Convention. The general impression was, it is said, that unless the British elections changed the situation, ratification of the Convention by these States was likely to take place before the end of this year. M. Fontaine (France) was re-elected president, and M. Carlier (Belgium) and M. Oudegeest (Holland), vice-presidents. Since the summer session, 40 ratifications of Conventions of international Labour conferences had been registered, it was reported, bringing the total number of ratifications up to 136.

Mr. J. T. Brownlie, the President of the Amalgamated Engineering Union, returned to London on October 13, after visiting several of the principal industrial areas of Canada and the United States. He was the British Trades Union Congress's fraternal delegate to the Canadian Trades Union Congress, whose annual convention took place last month at London, Ontario. He also represented his own union at the Quadrennial Convention at Detroit of the International Association of Machinists, and addressed meetings of metal workers in other centres. He found industry generally in the depths of depression, especially in the United States. About 60 per cent. of the organised metal workers owing allegiance to the American Federation of Labour, he said, were unemployed, and, in addition, many establishments were working short time.

The steel workers who have been on strike for eight weeks in the Sheffield district, have accepted new terms offered by the employers, yielding a bonus of 1*s.* 2*d.* a shift increase to the lowest-paid workers, and applying the district engineering rate in the case of semi-skilled men.

The *Monthly Trade Report* for September of the United Patternmakers' Association states that the number of unemployed members continues to rise. There was a further increase of 112 during the month, and the General Secretary regards the fact as "ominous." It is, indeed, a most discouraging sign, as its clear implication is that fewer orders are being booked and the industry's stock of work is running out. It is officially reported that at Southampton a payment by result system has been mutually arranged as between the employers in two shipyards and local members of the United Patternmakers' Association.

In the latest official reports of both the Amalgamated Engineering Union and the United Patternmakers' Association there are references to the negotiations which are in progress with the Engineering and Allied Employers' National Federation on the question of wages. A sub-committee was appointed by the unions, it will be remembered, to examine the figures submitted by Sir Allan Smith on behalf of the employers and prepare statistics in support of the men's application for an advance of 20*s.* per week. Apparently the sub-committee is nearing the end of its labours. The General Secretary of the A.E.U. says he hopes "to be in a position at an early date to again approach the Engineering and Allied Employers' National Federation in furtherance of our claim." The General Secretary of the U.P.A. says "The Joint Research and Information Department has the inquiry under way, and at any moment now, the committee expect to have a statement which can be put before the Trade Union representatives."

Interesting reports regarding conditions of labour were given at the Congress of Russian Building Trades, which was held at Moscow in May last. A summary of them, printed in *Industrial and Labour Information*, the weekly publication of the International Labour Office of the League of Nations, states that the actual value of wages in these industries rose to some extent in 1922 and at the beginning of 1923; but they are still largely insufficient as, on an average, they do not exceed 82·4 per cent. of the minimum living wage established by the State. Engineers' wages are barely 20 to 30 per cent. of the pre-revolutionary wage, while the lower technical staff receive less than a skilled worker. The continual increase in the cost of living tends further to diminish the actual value of wages, while constant delays in the payment of wages (in eight cases out of ten wages are not paid when due) make the position still more difficult.

The system of regulating labour, it is added, is very undeveloped in the building and public work industries, only 12 agreements being in force. It was mentioned at the Congress that the application of collective agreements left very much to be desired; for example, many of the clauses embodied in agreements concluded with the State Building Administration exist only on paper and are never applied. Again, in spite of the assurances given by the Central Committee, the workers are never consulted at the drafting of collective agreements.

Faraday House Old Students' Association.—The sixteenth annual dinner of the Faraday House Old Students' Association will be held at the Hotel Cecil on Friday, October 31, under the chairmanship of Mr. R. N. Vyvyan. Members of the Association may introduce guests, who need not be old Faraday House men. A musical entertainment will follow the dinner.

NOTES ON NEW BOOKS.

As a standard work, the late Mr. M. Powis Bale's book on "*Saw Mills*" retains the position it has enjoyed since it was brought out in 1883. Dealing, as it does, with fundamentals, it cannot be expected that there should be much in the way of change to chronicle. Recently, however, the introduction of new regulations has tended to modify practice in some directions, and the opportunity has, therefore, lately been taken of bringing out a new and revised edition of this work. This, the sixth edition, has been in the hands of Mr. A. Powis Bale, A.M.I.Mech.E., and the work now reappears brought up to date in many respects. A chapter is devoted to the new Home Office Regulations, which are reprinted by authority, thus making the work complete as a guide to good practice and modern requirements. In various sections the text has been improved. The references to cutters have been redrafted to conform to the new official regulations. Place has been found for recent developments, such as improvements in winches, the wider use of ball bearings, chain mortising machines, thermostats for timber drying, &c. With such additions and alterations and its sound original material, the work may be expected to continue to hold its own in the special field it occupies. The volume is published by Messrs. Crosby Lockwood and Son, London, at the price of 15*s. net.*

Engineering pocket books differ greatly in dimensions. Some of them would require for their accommodation a pocket not much smaller than the pattern in vogue with poachers, whilst at the other extreme we have books for which a waistcoat pocket is more than adequate. To this latter class belongs "*Steam and Other Useful Tables,*" which has been compiled by Mr. P. W. McGuire, M.I.Mar.E., and published by Messrs. E. and F. N. Spon, at 2*s.* net. The little volume is intended, we gather, mainly for the use of seagoing engineers. The steam tables included in the volume are based on Callendar's researches which are by slow degrees displaying the magnificent pioneering work of Regnault, as the recognised standard for the properties of steam. The other tables in the little volume have been selected as those most likely to be of immediate value to the reader. They include metric equivalents, a list of standard pipe flanges, particulars of the Whitworth bolts and nuts, and a number of useful data on boilers and their component parts.

Considering that the root of the term "alloy" is supposed to be the Italian word "lega" (league) we can hardly wonder that alloys partake of the undesirable as well as the desirable peculiarities of alliances. The alloy may be a good example of a compromise and show some of the properties of its several constituents; or the properties of the one constituent, and that not necessarily the quantitatively predominant partner, may mask those of the other constitutents; or the alloy may practically represent a new material with properties of its own. The study of the principles which underlie the changes caused by the admixture of foreign elements, sometimes in minute proportions, to metals is still a matter for the physical chemist rather than for the metallurgist. But theory and practice can certainly no more be separated in this field than in others, though the writer on the subject may only accentuate one or the other side. In "*Die Legierungen in ihrer Anwendung fur gewerhliche Zwecke*" [Berlin: M. Krayn; price 20 marks] Professor O. Bauer has, as the title indicates, practical objects in view. Half of the volume of 424 pages is devoted to the description of the technically important metals and alloys and their preparation; the other, first, half deals generally with crystallisation, phase diagrams, strength, hardness, &c. The volume represents the sixth edition of the well-known manual on alloys, an old favourite, originally published by A. Ledebur, which has grown into a fairly big book of 424 pages, and is popularly quoted now as "Ledebur-Bauer, Legierungen." As chief of the departments for metallography and inorganic chemistry of the Materialprüfungsamt, and vice-director of the Berlin-Dahlem Institut für Metallforschung, Professor Bauer has exceptional facilities for making such a book instructive. He describes some so far unpublished researches of his own on the instability of certain zinc-aluminium alloys; but we are rather surprised that he has nothing to say on Y-metal and other recent alloy researches of the National Physical Laboratory. Such deficiencies are perhaps accounted for by the vastness of the field.

Whether it is possible to make the ordinary user of electricity understand the meaning of "power-factor" we very much doubt. The prevailing ignorance of scientific matters is so profound, in spite of a generation of technical education, that most engineers would be satisfied to feel that the public had now grasped the fact that electricity was not produced "somehow or other by friction." However, as supply authorities frequently charge consumers more for their electric energy when the power factor is a bad one than when it is good, they must be constantly worried by the endeavour to explain the meaning of the term, and its effect on the cost of supply. To assist them in doing this the Electrical Apparatus Company, Limited, of Vauxhall Works, South Lambeth-road, London, S.W.8, have published "*The Power Factor Booklet*" containing attempts by a dozen different authors to deal with the subject in a manner comprehensible to the average consumer. These were originally written in competition for a prize offered for the best. They are all commendable in their several ways, but the part of the book most valuable to the technical reader is a section entitled "Power Factor Correction," by A. E. Clayton. This appears to be a complete reprint of one of the "Technical Primers" of Messrs. Sir Isaac Pitman and Sons, Limited. It occupies the greater part of the book and justifies its acquisition by those who have no need for the elementary analogies suitable for the non-technical public. The book is supplied at the price of 2*s.* 6*d.* post free, by the Electrical Apparatus Company, Limited.

The last 25 years have introduced to us a number of entirely new scientific concepts. The nature of an electric current is to-day visualised quite otherwise than by the preceding generation. The atom is no longer an ultimate particle of matter, and we have learnt a good deal as to its structure, and of the arrangement of the almost infinitely minute particles of which it is composed, so that we have a sub-atomic cosmology. At the other end of the scale we have succeeded in getting definite figures for stellar distances which there seemed no possible prospect of measuring 30 years ago, and we are also beginning to know something as to the processes going on in the gigantic high-temperature laboratories constituted by the fixed stars. The enormous mass of new data has been largely brought to rule and order, although there are very definite limits within which these rules apply, and we see flatly contradictory theories being held simultaneously by one and the same physicist, according to the special nature of the problem with which he is at the moment directly concerned. Such a condition of affairs is far from satisfactory, and would probably have appeared impossible to the savants of the Victorian era. The revolutionary character of so much of this modern work has naturally created a demand from people of culture for an exposition of it which shall be at once accurate, clear and readable. To meet this the Cambridge University Press has published an excellent discussion of practically the whole of these newer discoveries under the title of *Matter and Change.* The author is Mr. W. C. D. Whetham, F.R.S., and the price of issue is 7*s.* 6*d.* net. In its clearness of statement, and in its adequate but not too tediously detailed description of the fundamental experiments, the work recalls Ganot's Physics, and we trust it will prove as popular. Mr. Whetham is not merely a scientist, but is also a philosopher, and we fear that the mathematical purist who regards a force as simply one side of a certain equation may feel aggrieved at the author's insistence that we know intuitively what we mean by a push or a pull. Our own sympathies, however, are entirely with the writer. The work is divided into nine chapters, the first two of which deal with the properties of matter. Heat and energy, electricity and magnetism are next discussed, and then follows a capital exposition of the laws of chemical action and chemical equilibrium. The penultimate chapter describes the experiments which led to the doctrine of relativity. This doctrine is explained probably as clearly as is practicable without the aid of very advanced mathematics. A chapter on astro-physics concludes the volume, and gives a good account of the startling achievements of the last few years in this department of research.

The kinetic theory of gases has had a long history. It was Bernouilli who first suggested that gaseous pressure was due to the impact of moving particles. The matter was further advanced by Waterston in a memoir presented to the Royal Society in 1845, and which, apparently because it contained some errors of minor importance, remained unpublished for over sixty years. The foundations of the theory were, however, laid mainly by Joule, Maxwell and Clausius, and magnificent work in its development was accomplished by Boltzman. At the outset it was very evident that the hypothesis must contain a substantial basis of truth, as it accounted for many of the observed facts, and led to some striking and unexpected predictions subsequently verified by experiment, notable amongst which was Maxwell's conclusion that the viscosity of a gas must within very wide limits be independent of its pressure. There were, however, some serious outstanding difficulties, amongst which the apparent incompatibility of the spectra of gases, with their specific heats, was specially noted by Maxwell. Little by little, however, further light has been acquired. We are now able to detect effects due to single molecules, and Perrin, with his "artificial gases" made by suspending gamboge particles in water, has confirmed in a masterly way some of the most striking deductions from the theory. Moreover, starting from Maxwell's demonstration that the second law of thermodynamics is "macroscopic," not "microscopic"—true only of masses of molecules, and capable of evasion by agencies which can deal with single molecules—Boltzman has given a physical interpretation of entropy, which he found to be represented by the probability of any molecular state. Any assemblage of molecules tends to change from a state which is less probable to one of great probability, and hence the entropy of the universe always tends to increase and, apart from the action of mind can never spontaneously diminish. Unfortunately, in the recent past most textbooks dealing with the kinetic theory have been concerned mainly with the clearing up of outstanding difficulties, and have accordingly appealed mainly to the specialist. The need for a work of a less recondite character has, in fact, long been evident, and is well met by a treatise on "*The Kinetic Theory of Gases,*" which has just been issued by Messrs. Methuen and Co., Limited, at 7*s.* net. The volume in question is translated from the French of Professor Bloch by Mr. P. G. Smith. It is quite comprehensive in character and includes a discussion of Planck's quanta, which are playing so important a part in many modern developments of physical theory. The mathematical knowledge demanded from the reader should be within the compass of a good "third-year" student.

When Professor C. Bach, of the Stuttgart Technical High School, compiled the first edition of his "Elasticity and Strength" in 1889, some mathematicians and engineers were, in spite of the work of James Thomson, Bauschinger, Rankine and others, still clinging to the belief that solutions of the strength problems could be based upon the theories of the proportionality between stress and strain. Bach wrote chiefly for his students; but he wished to impress upon the engineer that he should always check the formulæ of which he made use, by experience, and that he should widen the range of his experience by systematic experimenting. In the experimental research Bach soon became himself a leader and an authority, and his textbook later rapidly passed through several editions. In the sixth edition of 1911 he was first associated with Professor R. Baumann. The full title of the ninth edition of "*Elastizität und Festigkeit,*" by C. Bach and R. Baumann [Berlin: Julius Springer; price 5·75 dols.] is supplemented by the addition: "the technically most important Rules and their Experimental Basis." In the eighth edition Bach had expressed the opinion that the primary task of mechanical science was now to interpret, to sift, and to co-ordinate the collected observational material rather than to adduce further material, except as to special features. The new matter in the ninth edition, which runs into 687 pages, unfortunately, without index, concerns mainly the strength of struts and progress in the improvement of metals by thermal treatment. There are also some excellent new photographs of fractures. The general treatment remains the same. As we have had enquiries recently we may add that, so far as we are aware, there is no English translation of this recognised standard book on elasticity and strength.

REFRIGERATING MACHINES AT THE BRITISH EMPIRE EXHIBITION.

During the height of the war meat supplies were brought from the Argentine, New Zealand and Australia, and landed in London for an inclusive charge for freight, refrigeration and storage of somewhere about 1*d.* a pound. The distances over which they were carried ranged from 8,000 to 12,000 miles and involved the crossing of the equator. The feat would, of course, have been impossible in the absence of refrigerating machines. It is but fitting, therefore, that several of our leading makers have made excellent displays at the British Empire Exhibition of refrigerating machinery on the successful working of which so much of our food supply is directly dependent.

The exhibit of the Haslam Foundry and Engineering Company, Limited, of Derby, includes several patterns of CO_2 refrigerator machines. Special interest attaches, perhaps, to one having a high speed compressor, which, as shown in Fig. 1, on page 560, is mounted on a crank case and is coupled directly to an electric motor, making a very compact plant of large capacity compared with its weight and the space occupied. Forced lubrication is provided for all working parts. A special feature of this plant is the liquid pre-cooling economiser, a section through which is represented in Fig. 2. The

REFRIGERATING MACHINES AT THE BRITISH EMPIRE EXHIBITION.

CONSTRUCTED BY THE HASLAM FOUNDRY AND ENGINEERING COMPANY, LIMITED, DERBY.

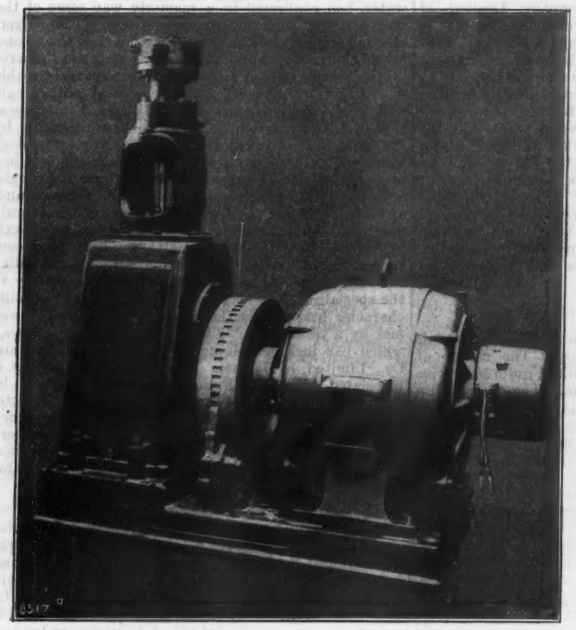


Fig. 1. High-Speed CO_2 Refrigerating Machine.

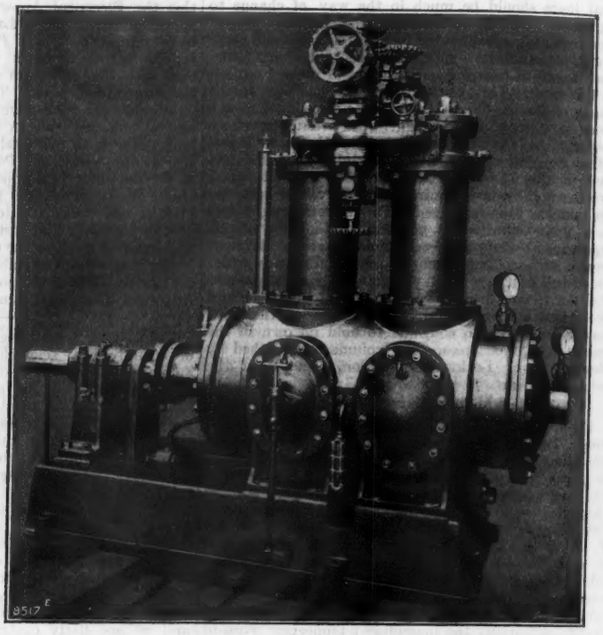
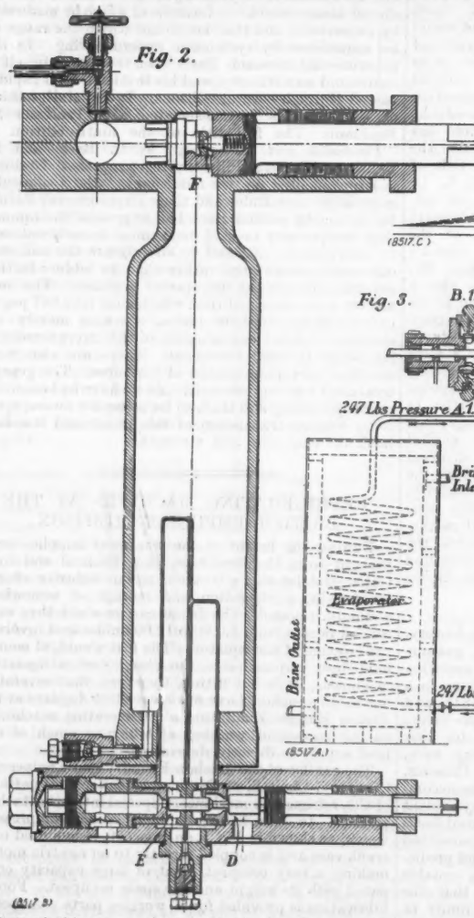
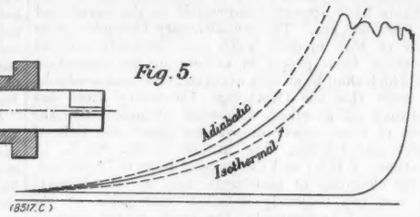


Fig. 4. High-Speed Ammonia Refrigerating Machine.





object of this apparatus is to maintain the capacity of the plant, when only relatively warm circulating water is available, as is the case in transport through the tropics. The principle on which it is based will be best understood on reference to Fig. 3, which shows diagrammatically the arrangement of the complete plant. The compressor differs from the ordinary type in having an auxiliary port at the middle of the cylinder, and a piston so long that this port is only uncovered at the end of each stroke. This auxiliary port communicates as shown with the top of the pre-cooler. In the ordinary arrangement, not embodying this device, the CO_2 delivered from the compressor at about 1,200 lb. pressure passes into a condenser where it is cooled to the temperature of the circulating water and is condensed to the liquid phase. It is then throttled through an expansion valve down to a pressure about of 247 lb. per sq. in., at which it enters the evaporator. The reduction of pressure at the expansion valve is accompanied by an evaporation of some of the liquid and a consequent large absorption of latent heat, giving rise to a great reduction in the temperature of the mixture of vapour and liquid which is forwarded to the evaporator, where it cools the brine in its passage through the coils and then returns to the compressor to commence a fresh cycle.

CO_2 has, as is well known, a low critical temperature, and at this critical temperature the latent heat of every vapour is zero, and is, moreover, small at lower but neighbouring temperatures. Hence, if the supply of cooling water has a temperature approaching the critical, but little latent heat is absorbed in the passage through the expansion valve. The consequence is that the ice-making capacity may be seriously reduced, so that a machine rated at 50 tons with circulating water supplied at 52 deg. F. may be good for but 23 tons when the cooling water has a temperature of 92 per cent.

By replacing the ordinary expansion valve by the pre-cooler this loss of capacity is largely avoided, and the machine working on this new cycle will, with circulating water at 92 deg. F., have an ouput 122 per cent. more than that of the usual pattern of machine, or conversely will take 40 per cent. less power for a given output.

The essential feature of the apparatus is that the expansion valve is "compounded," two such valves being arranged in series as indicated at D and E, Fig. 3. At the valve D the pressure is reduced from about 1,200 lb. to about 447 lb. per square inch. The gas liberated in this operation passes off through the valve F to the central port of the compressor, and thus raises the clearance pressure at the commencement of each stroke to about 447 lb. per square inch. The liquid CO_2 cooled by the evaporation produced in the passage through the valve D collects in the receiver of the apparatus and is then expanded through the valve E down to the evaporator temperature. It will be seen that by this arrangement only part of the gas is lowered to the temperature of the evaporator. By simply closing the valve F the machine can be operated on the ordinary cycle.

As already stated Fig 2 represents a section through the pre-cooler as actually made. In this section the valves D, E and F are lettered similarly to the corresponding valves in the diagrammatic sketch. It will be seen that the two valves D and E are regulated by a single spindle.

The firm also show their high-speed ammonia

REFRIGERATING MACHINES AT THE BRITISH EMPIRE EXHIBITION.

CONSTRUCTED BY MESSRS. J. AND E. HALL, LIMITED, ENGINEERS, DARTFORD.

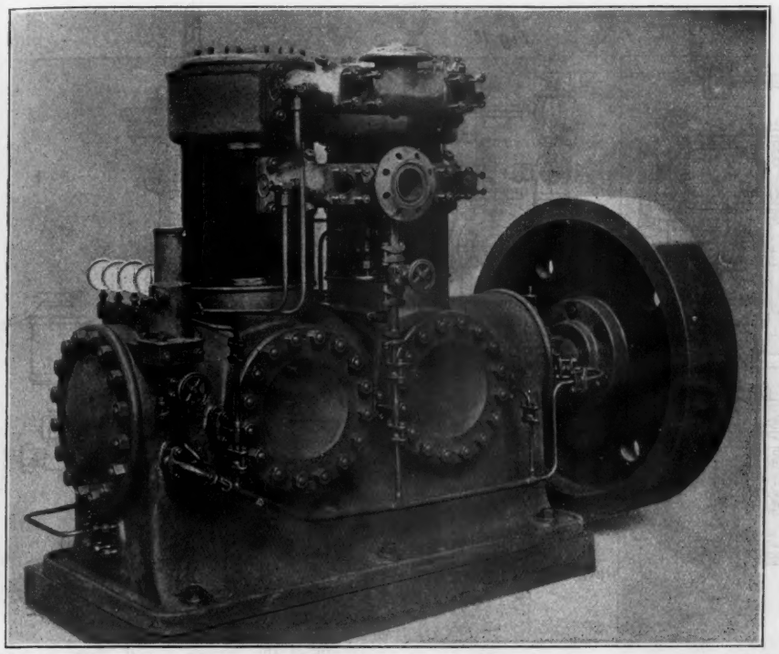


FIG. 6. TWIN-CYLINDER AMMONIA REFRIGERATING MACHINE.

Fig. 9.

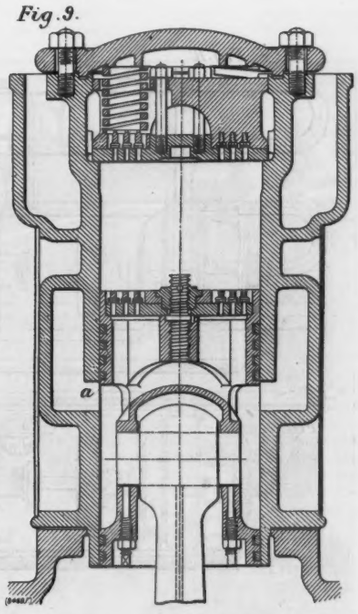


Fig. 7.

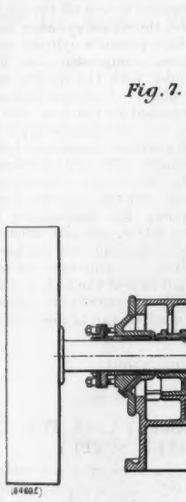
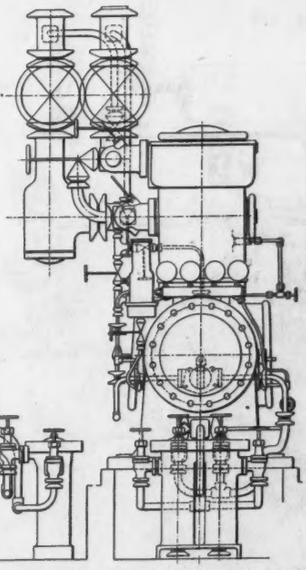


Fig. 8.



refrigerating machines, which have now stood most successfully the test of prolonged service. Two of these, each rated at 25 tons ice-making capacity, have already been working for nearly three years, during which they have required no adjustment and have made non-stop runs of 12 weeks on end. The original valves are still in use and show no signs of wear, although each machine has made about 145 million revolutions. A diagram from one of these ammonia compressors taken with a McDobbie-Innes Flashlight indicator is reproduced in Fig. 5.

A duplex machine of this type is represented in Fig. 4. It can be coupled direct to an electric motor, no reduction gearing being required. A machine of this type driven by a 50 b.h.p. Crompton auto-synchronous motor has been supplied by the makers to the New Zealand Government for the refrigerated exhibits of the Dominion at Wembley. The whole of the work in connection with this was carried out by the Haslam Foundry and Engineering Co.

Another firm which has an excellent display at Wembley is Messrs. J. and E. Hall, Limited, 10, St. Swithin's-lane, London, E.C.4. Perhaps the most interesting of their exhibits is the twin-cylinder ammonia machine, of which the general character is well shown in Fig. 6, whilst Figs. 7 and 8 represent longitudinal and side views, the former being partly in section. The two cylinders are each 8¼ in. in diameter by 10½-in stroke and are constructed of a very close-grained cast-iron. The pistons are of the trunk type with four packing rings at the top and two below (see Fig. 9). The suction port is shown near the bottom of the cylinder at *a* in Fig. 9, and from this the ammonia passes into the cylinder through valves arranged in the piston. These valves are of the ring type, and can be very readily removed for examination or replacement. The delivery valves, which are also of the ring type, are fitted into the cylinder head. The block in which they are mounted is, it will be seen, held in place by stiff helical springs, so that should, by any chance, a sudden rush of liquid ammonia occur, the block rises from its seat and allows the fluid to escape. It should, however, be also stated that the area through the ring valves is so large that it is but very seldom that this spring head is called upon to act. An additional safety device consists of a disc arranged in a by-pass between the suction and delivery branches. In the case of any great rise of pressure, the disc bursts, thus equalising the pressure in both branches. Moreover, it is impossible for the attendant to start the machine without opening the screw-down delivery valve, since the hand-wheel controlling this valve overlaps that of the screw-down valve on the suction side. Hence, the latter cannot be opened until after the delivery valve has been opened.

The machine is arranged for direct coupling to an electric motor, but can also be arranged for a belt drive if desired. The gudgeon pins are of hardened steel, and the connecting rod has a phosphor bronze bush at the top end and a white-metal bearing at the crank pin. The crankshaft is of forged steel, and is, as will be seen, carried in three bearings. Glands are provided where it passes through the casing, and the nuts for these are coupled together by a circular rack, thus ensuring uniform tightening. The casing is of cast-iron, and is provided with a large inspection door, and with oil-level indicators. Forced lubrication is provided to all bearings and also for the glands.

Oil strainers are fitted in duplicate on the suction side of the oil pump, and the connections are arranged so that either strainer may be removed and cleaned whilst the other remains in action, so that the compressor can run continuously for several months without shutting down. On the delivery side, an oil separator and drain to the crank case is provided. The machine is designed to run at 350 r.p.m., and special attention has been devoted to securing a very perfect balance, and absence of noise.

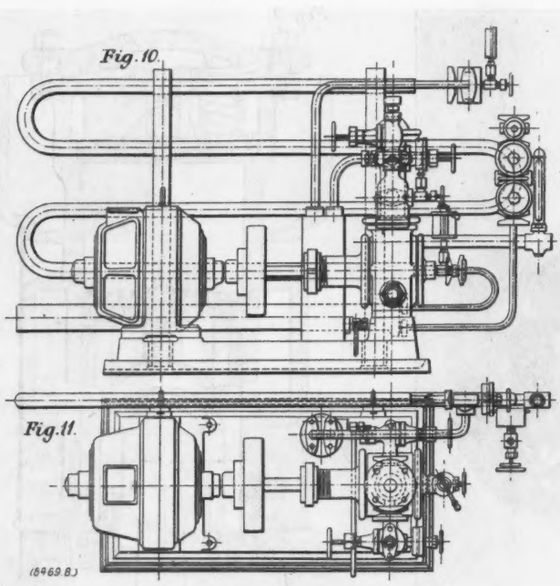
Another interesting machine is represented in Figs. 10 to 14, page 562. This is a small unit specially designed for butchers, small retail shops, small hotels or private houses.

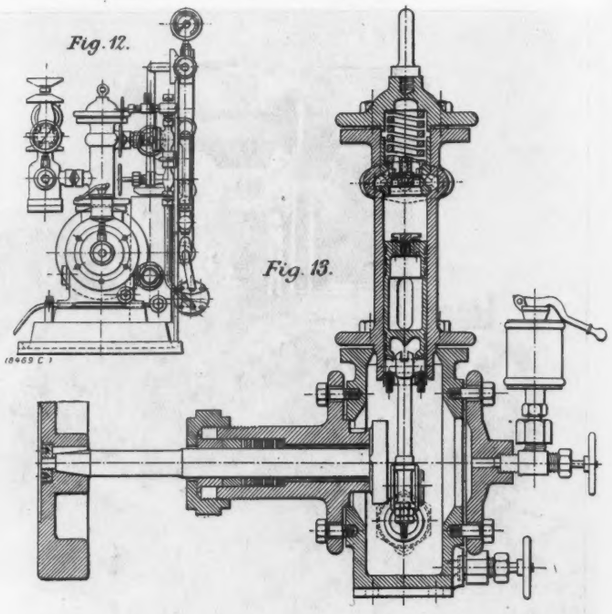
It is, as will be seen, arranged for a direct-drive by electric motor, which is of 1½-brake horse-power. It has a single cylinder, and long trunk piston and like the machine already described has the suction valve arranged in the head of this. The delivery valve is interchangeable with the suction valve, and both valves can be withdrawn and replaced without disturbing pipe connections. The position of the gudgeon pin ensures that it shall be efficiently lubricated by the oil in the crank chamber. The gland through which the crankshaft passes is perfectly gastight. Though a very small unit, it is fully equipped with oil strainer, oil-level indicator, drain valve, and oil pump for making up the supply without stoppage of the machine.

The unit is accordingly complete in itself, and it can be placed in any position, since it requires no special foundations. It is, moreover, very silent and free from vibration when at work, and it may be left

SMALL AMMONIA REFRIGERATING MACHINE; BRITISH EMPIRE EXHIBITION.

CONSTRUCTED BY MESSRS. J. AND E. HALL, LIMITED, ENGINEERS, DARTFORD.





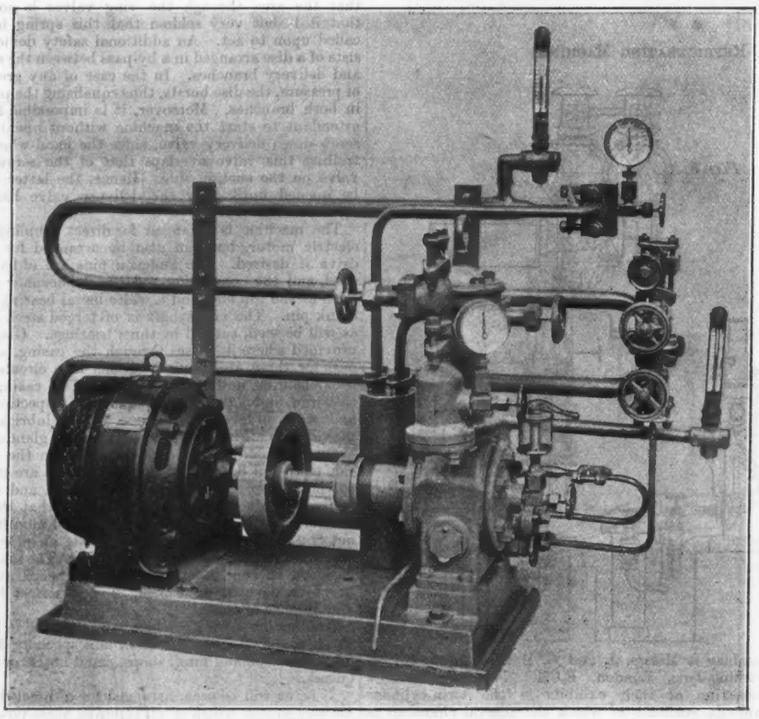


Fig. 14.

running practically all day without attention. This machine, it may be added, is now also being supplied for use at sea, where there is an increasing demand for small plants to refrigerate the provision room of cargo steamers. The makers also supply larger ammonia refrigerating plants for sea service. One such is represented in Fig. 15, on page 563. It is intended to be driven by an electric motor through a machine-cut spur-wheel gearing with a raw-hide pinion.

The firm also show CO_2 refrigerating machines. That represented in Fig. 16 is steam-driven. The CO_2 compressor and the steam cylinder are mounted side by side on a bracket, formed on the front portion of the frame, which contains the condenser and evaporator coils arranged concentrically within it. The two coils are, however, completely insulated from each other, so that all interchange of temperature is avoided. A special liquid-cooling device is supplied when tropical conditions have to be contended with, thus maintaining the output even when the water-supply to the condenser is as high as 80 deg. F. to 90 deg. F.

A large marine CO_2 machine is illustrated in Fig. 17, and is a type which has been fitted on the meat-carrying vessels plying between the Argentine, New Zealand, and this country. In consideration of the valuable nature of the cargoes carried, these machines are usually fitted in pairs, either machine being capable in an emergency of maintaining the necessary temperatures. As will be seen from the illustration, the machine consists of a compressor driven off the tail rod of a compound steam engine, the steam cylinders being arranged in tandem, the high-pressure cylinder occupying, with the forged-steel compressor, one half, and the low-pressure cylinder with the motion work the other half, of the base plate. A surface condenser for the steam engine is arranged in the base, and air and feed pumps, fitted on the side remote from the camera when the machine in question was photographed, are driven off the crankshaft. The CO_2 condenser, consisting of copper coils contained in a separate rectangular cast-iron casing, and the separate steam-driven vertical duplex pump for maintaining the necessary supply of cooling water, are not shown in our illustration. A duplex variant of this machine is also supplied by Messrs. Hall. In this case the compressors are driven off the tail rods of the high and low-pressure steam cylinders. Arrangements are provided by which either side of the machine can be disconnected and run independently of the other.

(To be continued.)

PIPE LINE FROM LAKE TANSA FOR THE BOMBAY WATER SUPPLY.

The City of Bombay has for some time past suffered from a deficient water supply. The water has hitherto been obtained from Tansa Lake 55 miles from Bombay, but the growth of the city has led to demands which the present reservoir could not supply until the storage facilities were increased by the construction of a larger dam, and a new pipe line. About 48 million gallons of water are delivered daily to Bombay, but this is now quite inadequate, and 90 million gallons will be supplied under the new scheme. This figure, moreover, is capable of expansion to 160 million gallons, before a further increase in the pipe line will be necessary. The contract for this new conduit which not only involves the laying of over 110 miles of water pipe, but the construction of 150 bridges, and the moving of 70 million cub. ft. of earth, has been taken by Messrs. Braithwaite and Co., of West Bromwich, Birmingham, acting in conjunction with Messrs. Dorman, Long and Co., Limited, of Middlesbrough, who have the contract to supply the steel work. The Tata Construction Company, of India, had the contract to prepare the track for the pipe line, and undertook the preparation of the line of route, and the excavation and embankment work is also being carried out by The Tata Construction Company.

The 90,000 tons of steel plates required were rolled at Middlesbrough by Messrs. Dorman, Long and Co.,

REFRIGERATING MACHINES AT THE BRITISH EMPIRE EXHIBITION.

CONSTRUCTED BY MESSRS. J. AND E. HALL, LIMITED, ENGINEERS, DARTFORD.

(*For Description, see Page* 559.)

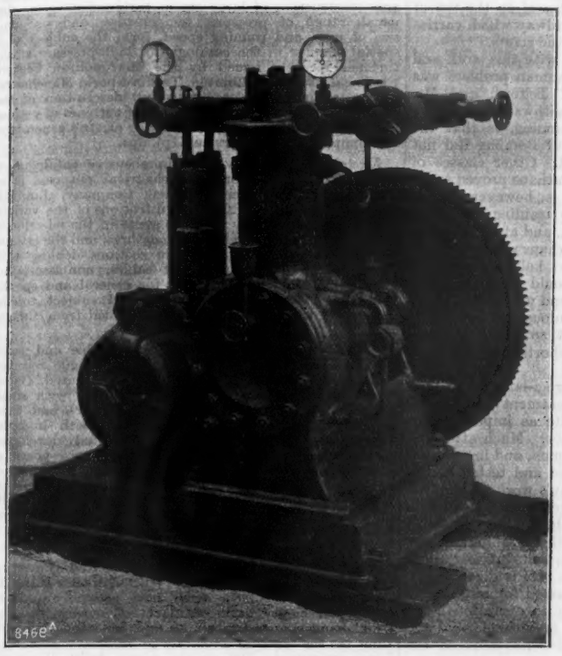


FIG. 15. AMMONIA REFRIGERATING MACHINE FOR SEA SERVICE.

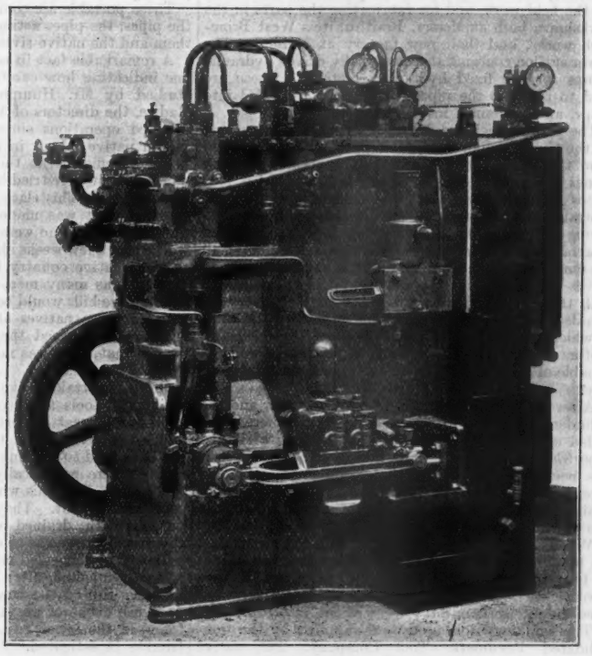


FIG. 16. CO_2 REFRIGERATING MACHINE.

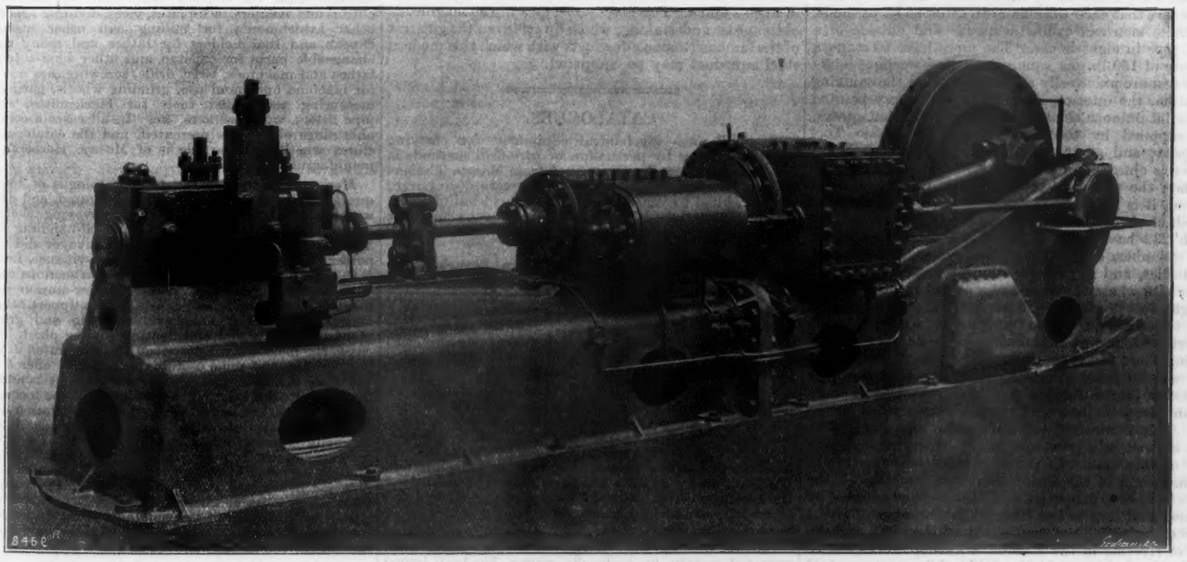


FIG. 17. MARINE CO_2 REFRIGERATING MACHINE.

Limited, whilst Messrs. Braithwaite and Co. undertook the work of forming these plates into pipes. This was done for the most part in their new works at Mulund on the Great Indian Peninsular Railway.

The special parts required, such as expansion joints, taper pieces, bends, elbows and manholes, were all produced at the West Bromwich works of the firm. The same contractors also carried out the work of laying, jointing, and painting the pipe line on the prepared track. The work involved many special appliances, for which compressed air was very largely used. The steel plates after being rolled at Messrs. Dorman, Long and Co.'s works, were cut there to size. This varied from 15 ft. to 20 ft. in length, depending on the size of the pipe, whilst the width was 7 ft. 4½ in. and the thickness ⅜ in. The edges were planed and the holes drilled to template. The magnitude of these two latter processes may be gauged from the fact that there were 700 miles of plate edges to be planed, 300,000 plate corners to be scarfed, and 40 million rivet holes to be drilled.

Thus prepared, the plates were shipped "flat" to India. By shipping "flat," instead of rolled, the shipping bulk was, of course, very much diminished, and the cost of shipment from England to India was reduced to one-fifth of what it would have been had the plates been rolled into pipes.

Numerous expansion joints have been required, since each 1,000 ft. of pipe when empty, expands as much as 6½ in. on a warm day, and it has been calculated that in very hot weather the movement may amount to 8½ in. To provide for this, an expansion joint has been inserted at every 1,000 ft. of the pipe line. Other "specials" also required in large quantities have been taper pieces, bands, branches, elbow outlets and manholes. These have all been made at the firm's West Bromwich works.

The new works which Messrs. Braithwaite have established at Mulund cover an area of 55 acres, and consist of a fabricating shop of five bays, 570 ft. long and 75 ft. wide. This workshop is electrically driven, the current being generated by three high-speed Belliss

and Morcom engines direct coupled to direct-current electric generators having an aggregate output of 800-h.p. The power station contains, in addition, two 14-in. by 14-in. air compressors, which taken together, are capable of compressing 850 cub. ft. of free air per minute. These machines are driven by electric motors and were supplied by The Consolidated Pneumatic Tool Company, of London, Bombay and Calcutta, who also provided the pneumatic tools used for the field work, and for fabricating the parts in the workshops, both at Messrs. Braithwaite's West Bromwich works, and their new factory at Mulund. The power station contains also electrically-driven hydraulic pumps for the fixed hydraulic riveters. These are used to rivet up the pipes when they are rolled into shape, and assembled inside the factory.

The plates which are delivered into the works siding by the Great Indian Peninsular Railway, are unloaded from the wagons by Royce 4-ton overhead travelling cranes fitted with electro-magnets which pick up four plates at a time and stack them on each side of the central bay of the works. So complete are the labour-saving arrangements that only two men are employed to arrange and supervise the stacking. No men at all are employed on the wagon, and the craneman merely drives his crane over the wagon and picks up a load with the magnet. In this way 120 tons of plates are handled per hour. The plates next pass to the rolls, of which there are four, each driven by 50 h.p. electric motors mounted on a tower. Each set of rolls is capable of turning out 112 tons of pipe in an eight-hour day.

After rolling, the edges are bolted together and the cylinders now pass to the riveting bays, where eight rolled cylinders are joined together forming a riveted pipe 57 ft. 4 in. long. A section of the pipe, after it has been rolled, is shown, Fig. 1, on page 550. The riveting is effected by 24 hydraulic riveters and specially designed travelling and turning gear is provided so that the pipe moves exactly the pitch of the rivet.

When the 57 ft. pipe section is completed it is picked up by a 10-ton overhead electric crane and transferred to the caulking bays alongside. Here the sections are carried on rotating stallways and the caulkers can accordingly work on steadily without interruption.

The caulking tools used were supplied by the Consolidated Pneumatic Tool Company. The native workmen who use these tools were all trained on a system organised on the spot by Mr. J. C. Telford, M.Inst.C.E., and Mr. W. A. Radice, A.M.Inst.C.E. The efficiency attained by these natives may be gauged by the fact that each workman can caulk 25 ft. per hour, and three men can caulk the inside and outside of a 57 ft. pipe in eight hours. The pipes have to stand a pressure of 150 lb. per square inch, and weeping joints under test are practically unknown. After the caulking operation, the interiors of the pipes are spray painted with a bituminous solution by pneumatic paint sprays, also supplied by the Consolidated Pneumatic Tool Company, and a remarkably smooth and impervious surface is obtained.

When the pipe has been caulked, painted and inspected, it is lifted by the overhead electric crane and placed on two specially designed bolster wagons, of which 232 have been built. Each 57 ft. length of pipe resembles a huge tank with each end resting on two bogies, and in this way the pipes are transported to the site where they are to be placed in position.

Eight to ten pipes thus mounted are analagous to eight to ten bogie coaches, and comprise a train. Seven powerful steam locomotives are constantly engaged hauling these trains to some part of the pipe line.

It will be noted from the foregoing that by this method of fabricating the pipe into 57 ft. lengths only one annular joint in every eight has to be riveted on the site. This method of fabricating the pipe line differs from all methods previously adopted in building pipe lines of this kind. In previous cases both in British Colonies, and in the United States of America all the rivets have been driven on site. The method adopted by Messrs. Braithwaite has reduced the number of rivets to be driven on site to one-twelfth of the total, and the cost of riveting in the Mulund workshop works out to one-tenth of the cost in the field, while on account of the many highly specialised appliances the speed of riveting is six times faster in the workshop. As there are 20 million rivets to be driven these economic considerations carry a great deal of weight. Fig. 2 shows the pipes being placed in position by means of the Goliath cranes which span the pipe line and pick up the pipes as they are delivered by train, placing them in position. The operation of lifting a pipe traversing and dropping it into position, i.e., telescoping it on to the end of the pipe already in position, takes on the average 12 to 15 minutes, though it has been done in less than four minutes.

As soon as each length of pipe is fitted into the end of the pipe line it is bolted in position with temporary bolts and nuts in the usual manner, ready for riveting by the pneumatic riveting hammers. So accurate is the templet work on the plates that no reaming of any kind is necessary. The rivet holes have lined up with amazing accuracy, and the joints are remarkably close.

Several hundred Boyer riveting and chipping hammers are being used on the field work. Compressed air is supplied from eight steam-driven portable air compressors, steam being selected on account of the ease with which fuel, chiefly timber, could be obtained, though recently two portable air compressors with petrol paraffin engines have been put into service.

These portable air compressors travel on the top of the pipes, the pipes acting as the railway which carries them and the native riveters close the rivets.

A remarkable fact in connection with this work and one indicating how carefully the human problem was studied by Mr. Humphreys, Mr. Telford, and Mr. Radice, the directors of Messrs. Braithwaite, who have directed operations since the beginning, is that the Hindu native labour in and around Bombay did not prove as efficient as they desired. Other classes of native labour were tried but only Pathans proved equal to the work. This class of labour is, however, scarce, but the most was made of it by training the small number of men who were available, and after they had worked for a few weeks all these Pathans were sent back to their native country for a short holiday, with the hint that as many men as they could tempt to leave their native hills would be trained and would earn large, and for these natives almost fabulous, sums. When these men returned they brought so many of their friends that there was no further shortage of the right class of workman.

In an undertaking like this, where a large number of pneumatic tools are used, the treatment of the tool itself is of great importance, quite as important, in fact, as the training of the operator. Much attention has been paid to training the workmen, and in addition the tools are periodically examined and tested in the tool room. Into this when the day's work is done the tools are brought. They are forthwith immersed in a paraffin bath, drained and then blown through with compressed air, so as to clean out the paraffin, and any sediment or congealed oil. A little light lubricating oil is finally injected, after which the tool is given a preliminary run on the bench and passed for re-issue.

In the event of any irregularity in operation being found in the bench run, the tool is withheld and the trouble investigated. This practice has reduced the cost of maintenance very considerably, and it is surprising how long these pneumatic tools operate without repairs when dealt with in this systematic way.

A long section of completed pipe line is represented in Figs. 3 and 4. This gives some idea of the magnitude of this great undertaking, which dwarfs even the greatest of the famous Roman aqueducts with which this modern steel aqueduct may be compared.

CATALOGUES.

Earth Boring.—Mechanical equipment for carrying out test borings by percussion or core-drill methods is illustrated in a catalogue received from Messrs. Thomas Wilson, Son and Co., 34, St. Andrew-square, Edinburgh, who have had 65 years experience in this kind of work. The firm undertake borings by contract, using power or hand methods as may be most economical in each case.

Telephone Apparatus.—The Western Electric Company, Limited, Connaught House, Aldwych, London, has sent to us a small quarto booklet of 32 pp., entitled "The World's Messengers." This has been issued as a souvenir of the British Empire Exhibition, and describes many of the firm's instruments for line telephony and their public address system. It concludes with a description of the company's exhibits at Wembley.

Locomotive Superheaters.—The production of the return bend of the elements of superheaters for locomotives gives rise to some difficulty owing to the sharpness of the bend and to the need for a smooth passage, both for the flow of the steam inside the tube and of the hot gases outside. The North-Eastern Marine Engineering Co., Limited, Wallsend-on-Tyne, have issued a catalogue describing the excellent design and construction of this part of the locomotive superheater manufactured by them.

Railway Workshop Machinery.—A specially interesting catalogue dealing with railway workshop machinery, operated mainly by hydraulic power, has been issued by Messrs. Henry Berry and Co., Limited, Leeds. The contents cover pumps, accumulators and intensifiers, portable and fixed riveters, cranes, hammers and pressses, and testing, weighing and other machines. Some of the presses shown are of very high power and large capacity, and they are adapted for various operations in forging, shaping, bending, rolling, tyre-fixing, &c

Electric Control Gear.—New editions of three catalogues from the British Thomson-Houston Company, Limited, Rugby, deal respectively with non-automatic electric control gear for squirrel cage, slip-ring and direct-current motors; automatic station control equipments for running isolated electrical machines; and alternating-current contactor type control equipments, suitable for various non-reversing motors such as those driving pumps, compressors, fans, blowers, &c. All these catalogues contain very complete information.

Oil Engines.—A catalogue of horizontal oil engines for working with refined or crude oil which has been sent to us by Messrs. Ruston and Hornsby, Limited, Lincoln, contains a description of a new type of engine intermediate between the Hornsby oil engine and the Ruston cold-starting type. It is a medium-compression type of engine which can be started by hand or compressed air after the vaporiser has been heated by external means. Six standard sizes, ranging from 8-h.p. to 36-h.p., are listed, and they are suitable for general work or for direct coupling to electric generators.

Steam Turbines.—Recent developments in the design and construction of large steam turbines, covering the usual range of pressure, temperature and vacuum, size of unit, and running speed, form the subject of a special chapter in the catalogue of high-pressure steam turbines recently issued by the Metropolitan Vickers Electrical Company, Limited, Trafford-park, Manchester. The catalogue also contains a full description of the parts of a typical turbine and a list of turbines of various types supplied or on order for driving electric generators, air compressors, blowers and pumps.

Electric Cables.—A very comprehensive catalogue of cables and flexible cords for electrical purposes is to hand from the General Electric Company, Limited, Kingsway, London, W.C. 2. Illustrations of the various classes are followed by tables to assist in the selection of suitable sizes the conversion of measures, and the estimation of costs. After these are sections dealing with association-grade cables, aerial cables, non-association class cables, and flexible cords for general and specific purposes. Standard prices are stated subject to discounts, of which a separate list is issued from time to time.

Portable Engines.—A series of portable and semi-portable engines is described in a catalogue received from Messrs. Marshall, Sons and Co., Limited, Gainsborough. There are seven standard sizes with single cylinders, three with two simple cylinders, and three of the compound type, all working with a boiler pressure of 150 lb. per square inch and developing from 7 brake horse-power to 52 brake horse-power at economical loads. The particulars given of a test of a single-cylinder engine show that 30·73 brake horse-power was developed with a consumption of 2·33 lb. of coal and 20·17 lb. of water per brake horse-power-hour. The quality of the coal used was such that it would be equal to 2·04 lb. of best Welsh.

Tools.—Messrs. Alfred Herbert, Limited, Coventry, have sent us a copy of a revised edition of their catalogue of "Small Tools"—a term now generally used to include accessory parts of machines, general supplies, small hand-operated machines and hand tools, in addition to the cutting tools for machines. This catalogue extends to 500 quarto pages, fully illustrated, and includes tables of particulars of various sizes where necessary; prices are mentioned in nearly all cases. It is very difficult to classify the contents, but we may mention that the articles dealt with include milling cutters and reamers, face-plates, vices, dividing heads and other attachments for milling and other machines, chucks and tool holders for lathes and many special changeable parts for capstan and other semi-automatic lathes and machines, twist drills, screwing dies and taps for machine and hand use, grinding wheels, gauges and measuring tools, and tools for blacksmiths, fitters, pipe fitters, wood workers, &c. In all cases a considerable range of firms is presented, and the catalogue also states whether the article is of Messrs. Herbert's own manufacture or not.

Mechanical-Handling Plant.—A catalogue of 150 pp., quarto, well printed, bound and illustrated, and dealing with the various types of lifting and conveying machinery now known collectively as mechanical-handling plant, has been received from the Mitchell Conveyor and Transporter Company, Limited, 50, Holborn-viaduct, London, E.C. The catalogue is divided into ten sections dealing with locomotive-coaling plants, power-station equipments, belt conveyors, skip hoists, wagon tippers, telphers, transporters, aerial ropeways, crushing and grinding plant, floating cranes and floating coaling plant. In all cases, the machinery is described and illustrated in working position, and some useful information is offered as to the best methods to adopt under various conditions. Some interesting particulars are given of the locomotive coaling plant, the largest of its kind in operation in this country, installed by this firm at Nine Elms, London. In many cases, grinding, crushing, screening and other machinery must be incorporated in the handling scheme, and the selection of this class of plant illustrated is suitable for heavy and continuous service. The catalogue is of a specialist character, in that it is devoted to the particular problems of the handling of materials, but it serves to show the great variety of mechanical appliances involved in the solution of those problems.

THE RAILWAYS OF INDIA.—We are informed that Sir Seymour B. Tritton, K.B.E., M.Inst.C.E., of the firm of Messrs. Rendel, Palmer & Tritton, civil and consulting engineers, Westminster, is going to make an extensive tour of India, Burma and Assam during the forthcoming cold season. We understand that his visit is made at the request of the Chief Commissioner of Railways in India, and the object is, in the first instance, to confer with the Chief Commissioner and the Railway Board in India on questions relating to the standardisation of locomotives and rolling-stock, and several other important matters in connection with the working of the railways in India. He is also visiting the other railways and port authorities in India for which his firm act as consultants, to inspect their workshops and rolling-stock, and to consult with them on various projects in hand or under consideration. Sir Seymour will be accompanied by his son, Mr. Julian S. Tritton.

LARGE ALTERNATORS.*

By A. B. FIELD, M.A., B.Sc.

FROM the point of view of our present outlook for the near future, the generation of electrical power on a large scale will be alternating-current generators driven by water or vapour turbines. In either case relatively large units will be the order of the day. For our own home production of power in the British Isles we are chiefly interested in coal-burning stations. But our outlook is much wider than this; for, small though our island is, it is the manufacturing centre of an Empire, and thus the unit consisting of a generator coupled to a water turbine for medium and for high hydraulic heads becomes an important item of our factory products, filling orders from the Dominions, the Colonies, India, and from foreign countries; our Canadian interests too, cause us to follow with the keenest appreciation the details of those ponderous monsters of the Niagara development which, because of their size and weight, are more appropriately brought into being somewhat not too far removed from their ultimate home.

The present position may conveniently be considered in reference to the three features: (*a*) Reliability; (*b*) Operating Cost; and (*c*) Operating Convenience. Each of these in reality involves a complex group and to some extent merges into the other two. In the present communication it has only been possible to deal with a few items under these heads.

(*a*) In the matter of the first feature, it may be said at once that a considerable degree of reliability has been attained already if we consider the question broadly; that is to say, the frequency of actual interruption of service due to generator failures is not great; this is partly due to elaborate protective gear, and to skilful supervision by which a machine is taken out of service and overhauled before it breaks down. But there is yet room for improved inherent reliability.

(*b*) Under the second heading we may first consider the efficiency item; we realise the very low overall thermal efficiency that holds, but since the modern large turbo-generator returns in the desired electrical form some 96 per cent. of the energy supplied to it mechanically, there is hardly room for an electrical contribution to any spectacular improvement here, unless it be in the direction of an adaptation to some new special requirements of the prime mover by which an enhanced efficiency of that part of the set can be secured. However, on a small scale there is certainly something yet to be achieved in the reduction of stray load-loss, windage and ventilation loss, and probably core loss; these are touched upon later.

(*c*) Operating convenience is a matter to which some weight should be given as a distinct item, although it will no doubt be argued by many that all these three features (*a*), (*b*) and (*c*) should be comprised under "Operating Cost" if that term were really interpreted widely enough; it is convenient however to give it a somewhat more restricted meaning.

The question often thrusts itself upon one, whether the turbo-generator would bear any great resemblance to its present day representative if the general problem in its more recent shape had presented itself bluntly for solution, instead of slowly coming forward in a succession of stages in relation to a machine evolved from small engine-type or water-wheel-driven units.

Considering the many features which are distinctive of the large machine of two or four poles, such as:—Large air gap, great radial core depth, great axial length, great coil span, and so on, it would seem that the natural attack, if made *ab initio*, might not improbably have proceeded along different lines. The size of the units desired, running up, let us say, beyond 50,000 kv.-a., would have suggested terminal voltages of the order of 25,000 as being convenient from all points of view; while a mechanically sound though reasonably compact and well cooled system of supports and fixing for coils and connections would have been a prime requirement that we should set before ourselves, with the added proviso that the greatest care would be needed to avoid incurring heavy stray load losses in connection with these requirements.

We should have foreseen the great space concentration of electrical conductors and magnetic material that would have been inevitable. Even though optimistic, we should have had to accept the probability of the total losses to be dealt with running up to say, 1,500 kw. per machine. We should then have remembered the order of the cooling constants applicable to the usual type of air-cooled machinery, involving generally considerably under 1 watt per sq. in. at the cooling surface. The contemplation of this treble combination would surely have forced our thoughts in envy to the rate of heat transfer that can take place when steam condenses on a tube, say some 180 watts per square inch for air-free steam with a 20 deg. C. temperature difference. We doubtless should then have jotted down some such rough comparison as given in Table I:—

TABLE I.

	Watts per square inch.
Past practice in air-cooled electrical machinery .. (Multiply by two and a half for axial ventilation).	0·5 to 1
Rate of heat transfer, steam condensing on a condenser tube with 10 deg. C. temperature difference, under ideal conditions	100
Current practice in surface condensers: rate of the double transfer of heat, from steam to metal and thence to water, with 10 deg. C. mean temperature difference between steam and cooling water	30
Actual rate of heat transfer from tube to water in Bonecourt boiler tube	20 to 40
Ditto, in Nicolson high speed boiler	100
Rate of transfer from smooth metal tube 1 in. diameter to water flowing at 500 ft. per minute with 10 deg. C. temperature difference..	60

With the problem presenting itself in some such manner as here outlined, would it have been surprising had we embarked on an exploration of other cooling methods than by air circulation? Our inclination to do so would have been further stimulated as soon as we considered the relative volumes of the different cooling media with the consequent cross-sectional area of ducts required; see, for instance, Table II.

In the first place, we should have appreciated that a sufficiently large air gap was possible to allow of a mechanically sound partition between the rotor and the stator, as, for instance, might be constituted by a cylinder of Bakelite Micarta an inch or so thick; influenced then by transformer practice, we might have found an oil-immersed stator attractive, while for the cooling of the rotor we might, no doubt, have again used either oil or water circulation, somewhat along the lines of the system that has been practised in a few instances by Messrs. Parsons.

The oil-immersed stator would have appealed to us from the point of view of the insulation problem, and would have immediately rendered a machine voltage of 25,000 as simple as, say, the 10,000 volts of the air-cooled stator, thus helping out the switchgear problem when very large units were in question. It must be remembered in this connection also that the amount of insulation used on the present high-voltage stator windings—for instance, in the slot—is the result of empirical determinations of that necessary to meet a group of conditions of which the breakdown voltage per millimetre thickness under a laboratory test is only one, and perhaps a minor one; for an oil-immersed stator it is to be anticipated that less insulation thickness would be required for a given voltage.

In the detailed application of the oil cooling we should have departed at once from the usual transformer practice with its sluggish convective circulation and its low rate of heat transfer, represented by one or two watts per square inch of cooling-pipe surface; an essential feature of our oil-immersed stator would have been the forced circulation of the oil under a head of 1 or 2 ft. per foot-run of duct, rendering available a transfer rate of well over 30 watts per square inch for a temperature difference of 10 deg. C. In the case of a high-voltage transformer it is undesirable continually to withdraw the oil and pass it through a mechanical pump, but the highest generator voltages likely to prove advantageous would be low from the point of view of the transformer builder. The possibility of a sudden rise of pressure in the oil, due to a stator fault or short circuit developing, would have been allowed for and means provided for immediate venting in such circumstances to avoid injury to the air-gap partition.

Had we looked at the problem from a slightly different angle, we might well have felt that the claims of some form of evaporative cooling were sufficiently insistent to warrant researches for an ideal medium. Some of the chlorine compounds, such as carbon tetrachloride (CCl_4), combine very important assets, such as fire and arc-extinguishing properties, greatly increased electrostatic strength, &c., with certain serious drawbacks, such as slightly corrosive action in the case of their commercial grades and injury to the insulating gums at present used. There are similar objections to dichlorethylene and trichlorethylene. Some other compounds of suitable boiling points are poisonous or inflammable, or are ready to combine with water with an acid reaction—and so on. However, it would probably not have been too optimistic to think that chemical and physical research might bring to light either a suitable medium or methods of insulation suited to the use of CCl_4 or C_2HCl_3. Expressed very crudely, the problem of withdrawing the heat from the copper and iron is a double one: first, the thermal conduction to the surface of transfer second, the interchange thereat from the surface to the cooling medium.

It would, of course, be useless to push a solution of the second step so far that the first one became entirely predominant, and this must be borne in mind. However, with this reservation, it is instructive to remember, first, the large amount of interface surface that we have to reconcile ourselves to with air cooling and to bear in mind that 10 per cent. of this, or less, would amply meet the actual interface conditions of transfer with, for instance, oil circulation; and secondly, to note the great aggregate cross-sectional area of duct that is required for air conveyance, and the extent to which this hampers us by increasing the power losses and the weight of the machine. The comparative figures in Table II, which should be taken as illustrative rather than as a precise statement, are sufficiently striking in this latter connection. The volume of ducts actually required to carry the oil when this medium is used for cooling is seen to amount to less than 5 per cent. of that demanded by an air-cooled system.

TABLE II.—*Comparison of Weights and Volumes of Cooling Media, and Cross-Sectional Areas of Ducts, for Dealing with* 100 *Kw. Losses.*

Column No.	1	2	3	4
Method of cooling	By raising the temperature of the medium.		By evaporation.	
Cooling medium	Air	Oil.	Water	CCl_4
Temperature rise of medium ..	25° C.	10° C.	Nil.	Nil.
Weights, lbs. per minute ..	530	630	5·5	65
Cubic feet per minute—				
Entering			0·09	0·7
Leaving	8,000	11·8	1,900	420
Approximate cross section of ducts, square inch	250	10	20	20

In Table II, it will be noted, a temperature rise of only 10 deg. C. has been assumed for the oil, versus 25 deg. C. for the air, but in spite of this a duct cross section of 4 per cent. of that required for air would suffice as far as conveyance of the oil is concerned. In addition to the lower rise of temperature of the medium, a smaller temperature difference can be allowed between the duct surface and the medium with oil cooling; in these two ways provision can be made for lower actual machine temperatures and for a greater thermal conduction drop from the seat of loss to the cooling surface. Column 3 is based upon a steam temperature of 38 deg. C. corresponding to a 28-in. vacuum; the 15,000 ft. per minute steam velocity assumed at exit is conservative for a medium of so low a density. The air velocity assumed in column 1 is 4,500 ft. per minute. Column 4 is based upon a sub-atmospheric pressure, viz., about 6 lb. per square inch, giving a boiling point of 50 deg. C. for the carbon tetrachloride. The vapour at this pressure is denser than air, and an exit velocity of 3,000 ft. per minute is assumed. The latent heat of CCl_4 is low, about 8·5 per cent. of that of steam at the same temperature. Research seems to be needed upon the effect of the magnitude of latent heat on the rate of heat transfer when change of state is taking place at an interface; information on this would render a large amount of steam data available in other connections.

The greatly increased heat conveying power of each square inch of cross-section of duct when either oil cooling or evaporative cooling is resorted to, compared with that of an air-carrying duct has certain far-reaching effects. To mention one: hollow stator conductors have been used to a small extent in that type of machine in which the ventilating air passes straight through from end to end. Cool air is thus admitted at one end of the conductor and has the advantage of playing directly upon the bare copper during its passage. In the writer's opinion, the arrangement is comparatively ineffective for the following reason among others; there is a suitable ratio of cross-section to perimeter of duct corresponding to a given air velocity and temperatures of air and metal; this ratio increases nearly in proportion of the length of the duct between entrance and exit. Now the size of duct permissible in a hollow conductor is very inadequate from this point of view; nor can the length of run be halved, because we are unwilling to interrupt the insulation of the slot portion of the conductor in the only case where there might be much justification for this method, namely, that of a large, high voltage winding. The position is entirely changed, however, when we reach the heat conveying figures referred to for the other media. It is not to be inferred that hollow conductors would necessarily be advisable; in some cases possibly a better solution might be found in a conductor compactly wrapped with mica and then closely encased in a thin metallic sheath, perhaps of high resistance material such as nickel, applied in sections of short length each. The sheath might be applied on top of a light conductor insulation with the main part of the mica outside it, or it might be outside the greater part of the insulation. This armour-clad conductor, the insulation of which would be debarred from loosening, would be subjected to cooling by ducts around it, and room for such duct spaces, having all the cross-section requisite for heat conveyance, could be found without serious sacrifice either electrical or magnetic.

While dealing with the question of cooling, it may be well to consider for a moment one other direction in

* Paper, abridged, contributed to Section G of the World Power Conference on July 7, 1924.

which perhaps insufficient attention has been given to the problem, though here again the matter has by no means been entirely overlooked. We refer to the question of using some other gas or vapour than air; or air at a pressure other than atmospheric, in a closed self-cooler installation. It would be necessary to bear in mind any physiological effects of leakage from the system, and the cost of such leakage; we should also look for the possibility of obtaining fire extinguishing qualities or improved dielectric strength. Apart from these, the essential criterion would be the ventilating power required for removing a given number of kilowatts, using a given ducting; or conversely the extent to which the ducting could be reduced for a given ventilating power.

Now Lanchester, drawing attention to the similarity of the molecular mechanism by which frictional resistance arises at the interface between a solid and a fluid, and that by which heat passes from a surface to a cooling medium which scrubs it, inferred that there should be a close direct relationship between the power called for by the friction, the velocity, the specific heat, and the rate of heat removal, the relationship being largely independent of the physical constants of the cooling medium. This really is in conformity with Osborne Reynold's theory published in 1874, as we have been reminded by Stanton. We could assign relative figures of merit to the different gases that might be used for cooling purposes. A somewhat more convenient procedure is to assign figures which are the inverse of these, and which represent the relative amounts of power required for circulating the cooling medium with a given ducting and given limiting excess temperature of duct surface above that of the ingoing gas. Without going into details here, it may be said that upon the basis referred to above, and expression for this figure of demerit may be put into the form :—

$$\frac{(k\,a\,+\,\sigma)^5}{w^2\,\sigma^4} \quad . \quad . \quad . \quad (1)$$

where :—

w = lb. per cub. ft.
σ = specific heat at constant pressure.
a = ratio of effective cooling surface area to cross sectional area for the conveyance of the medium.
k = a constant, independent of the medium.

It will be pointed out, quite justly, that the actual pneumatic power represented by the volume and pressure of air circulated is very much greater than that involved in the friction at the duct surface; in fact, it is often more than twice this amount. However, if it be allowed that this additional power is called for by losses that are chiefly of the nature of those arising when an air stream turns a sharp corner or when it encounters a sudden change of cross section of its duct, then with regard to this part of the power we may use a criterion figure represented by the expression (1) multiplied by σ, namely :—

$$\frac{(k\,a\,+\,\sigma)^5}{w^2\,\sigma^5} \quad . \quad . \quad . \quad (2)$$

If we take, for the purpose of a rough general survey of the matter, that the ventilating power is equally divided between the two kinds of resistance mentioned, we may add expressions (1) and (2) together, and use the sum as our criterion figure. Taking a more or less typical value for σ applicable to existing practice with circular ventilation holes, which makes the numerator of (1) proportional to $(0{\cdot}3\,+\,\sigma)^3$ we find values as tabulated below :—

Table III.

Medium.	Relative Figures of Demerit. For Duct Resistance.	For Stray Ventilating Power.	Average of Previous Two Columns.
Air at atmospheric pressure	1	1	1
Air at 3 lbs. per square inch above atmospheric ..	0·68	0·68	0·68
CO_2 at atmospheric pressure	0·61	0·53	0·57
Nitrogen, ditto	0·98	1·02	1

Such figures would indicate a 30 per cent. reduction of ventilating power with air cooling by increasing the pressure 3 lb. per square inch, and a 40 per cent. reduction by using CO_2 at atmospheric pressure.* Expressed a little differently, we may say that on the basis of these figures the temperature rise of the duct surface above ingoing gas temperature would be 12 per cent. and 17 per cent. respectively less with these two methods of cooling than with air at normal pressure, assuming the same ventilating power in all cases.

* The windage of the rotor, in the medium in question, should also be considered

Had we included hydrogen in the tabulation we should have found a high figure of demerit for it; this would have been deceptive for the following reason: ventilating performance would generally be improved by increasing the area of duct cooling surface beyond that afforded by the simple circular vent hole, but the improvement would be of the same order for all the gases given in the table; in the case of the light gases, hydrogen and helium, however, the improvement would be at a much more rapid rate, and we ought therefore to assume that the ducting for use with these gases would be specially designed to suit them, giving higher velocities and much larger surfaces per square inch of cross sectional area, for instance, by making the cross section a flat oval. The position becomes clearer by remembering that hydrogen has a specific heat about 14 times that of air; in fact, the volumetric specific heat is practically the same as those of air and its constituent gases, so that for a given temperature rise of the gas between entrance and exit it would only be necessary to circulate the same number of cubic feet of hydrogen as of air, but with this circulation the hydrogen would be unable to scrub off from the duct surface the same watts per square inch as the air, except with an increased temperature difference; hence larger surfaces and higher velocities would naturally be provided. It seems probable that with increased velocity, and with the surface increased to four times the air value, hydrogen cooling would become more effective than air cooling, but for a direct and fair comparison a detailed discussion involving a number of features would be necessary. It is noteworthy that the Osborne Reynolds-Lanchester relation between surface frictional resistance and watts per square inch heat removal, referred to above, is applicable to liquids as well as gases.

The power expended in windage and ventilation generally exceeds 1 per cent. of the output; the item is therefore worth attacking if any probability comes in sight of materially reducing it without detrimental effects in other directions. Hence this discussion. In the case of cooling by liquid circulation the greater part of the item would naturally disappear.

Core loss is one of the two remaining principal items of loss; an appreciable reduction of the core loss would follow again upon the use of liquid cooling in consequence of the greatly diminished duct volumes.

As regards the third item, reference has already been made to the large value of stray load-loss which we still countenance. Of this, the amount arising in the conductors themselves due to cross-slot flux and main flux is now kept down to a reasonable limit by methods well established, and represents but a small proportion of the total; part of the remainder occurs in the active cylindrical surface of the rotor, and can be considerable reduced by the use of an adequate system of longitudinal and circumferential dampers on the rotor; another relatively large portion is associated with that part of the stator winding which is external to the slots, and which is the seat of large and far-reaching stray magnetic fields causing loss in various parts of the structure. One step in the reduction of this last item of loss is to be looked for by the use of the grade of cast iron known as No-mag, which has been made commercially available by Messrs. Ferranti, Ltd., recently; it has a high resistance and is practically non-magnetic. The loss is accentuated somewhat by the use of magnetic steel for the rotor end rings, but until we have available a more suitable substitute for chrome nickel steel than the manganese bronze or the 25 per cent. nickel steel sometimes used in smaller machines, the manufacturer is amply justified in using the first-named material and accepting the extra loss. It is submitted, however, that the broad problem of further reducing the stray load-loss is one which still deserves close attention.

While touching on the subject of end rings, the hope may be expressed of further help from the metallurgist. Manganese bronze rings can be obtained having extremely good tensile strength and fair ductility; such rings have been used a good deal for smaller rotors, for single phase machines, and as narrow spacer rings in conjunction with main rings of chrome nickel steel. This material, although termed bronze, contains but an insignificant amount of tin while its zinc contents amount to some 37 per cent.; it suffers in consequence from some of the diseases to which other brasses are prone. The effect of mercury, even in small traces, in causing brasses to become rotten and lose strength and ductility has long been known. No more than the contents of the bulb of a mercury thermometer, coming into intimate contact with the surface of one of these bronze rings, may easily result in the failure of the ring. But the danger from solder has not, it is believed, been so well recognised hotherto. An investigation on the subject was made by Mr. J. H. S. Dickenson. Caution is needed in the use of these rings, even when the joints of the rotor winding itself are silver-soldered or brazed. A non-magnetic material without these disabilities, and having the good features of manganese bronze, would be most useful, and if in addition there could be obtained a stress-strain characteristic similar to that for steel, *i.e.*, showing a high value of true elastic limit, then a considerable advance would have been made.

Reverting to the stator construction and a possible reduction of stray load-loss; the suggestion was thrown out some years ago by Professor Miles Walker, of rendering practicable for the stator that oldest of all types of winding, the ring winding, by carrying the external return conductors inside copper tubes, which themselves would be bonded to a squirrel cage ring at each end. In the practical application it might prove preferable to use open channels instead of the tubes, or merely to sandwich each active conductor tightly between two of these compensating bars. The end-ring, connecting together compensating conductors, might take such a form as to serve also as the supporting structure for the radial end connections of the stator winding. These end connections linking the air-gap conductors with the peripheral ones, might well take a semi-elliptical or even a semi-circular form, such gradual bends being ideal for insulation. The extreme simplicity of such a winding would be very attractive, while the problems of insulation, of mechanical bracing, and of cooling the end connections, would have gone far towards solving themselves.

The objections to the arrangement are self-evident and may quite possibly prove predominant; but if it should prove capable of effecting an appreciable saving of load loss, over and above the additional I^2R loss incurred in the active and compensating copper, then the arrangement would certainly deserve consideration. It is not easy to forecast the effect of such a change on the stray load-loss, since circumferential currents would still be carried at each end of the machine, corresponding to the aggregate circumferential ampere conductors of the present windings; but the current paths would be simpler, and their location more at our disposal, while the currents flowing would have the nett values representing the resultant of the several independent currents which partly counter-balance one another in the normal type of winding.

A change to such a winding would perhaps involve some 40 per cent. additional active copper, with, say, a further 50 per cent. for the compensating copper excluding end rings, thus about doubling the stator copper. This sounds serious both from the point of view of I^2R losses and that of cost, but we must note that stray load losses frequently run to five and sometimes ten times the I^2R loss, so that there is a distinct possibility there. The question of cost also is partly wrapped up in that of losses, of inherent reliability, and of simplicity of construction and ease of repairs; the true capitalised value of a gain in any one of these features is very great, and would pay for a considerable amount of copper, even in the expensive form contemplated.

Ship's Lifeboat Wireless Tests.—Some trials were recently carried out during a voyage of the P. and O. liner Maloja of the Marconi wireless equipment for ship's lifeboats, with which the vessel is fitted. Preliminary trials in the Mediterranean with the lifeboat hoisted gave satisfactory results. A further test at Melbourne with the lifeboat cruising in Port Philip resulted in strong signals being received by the boat from the Maloja and neighbouring wireless stations, the operator being enabled to obtain bearings of any of the latter by means of the directional receiver of the set, within one point of the compass. The transmitting range of such a set is 50 miles.

Sulphur.—Lecturing upon "Sulphur" at the Institution of the Rubber Industry on the 6th inst., Mr. E. Anderson, of Edinburgh, said that the many chemical and physical peculiarities of sulphur—the most important raw material of the rubber industry apart from rubber itself—were probably connected with its still obscure action upon rubber. Sulphur, rhombic under ordinary conditions, occurred also in monoclinic crystals and in two amorphous modifications. The fused sulphur turned dark and viscous at 250 deg. C., but mobile again at 300 deg. C. The ordinary sulphur molecule consisted of eight atoms and dissociated into molecules of two atoms at high temperatures. All the modifications were soluble, to different extents, in rubber. Vulcanisation had been regarded as a purely chemical process and as a physical absorption process; it was probably a combination of both. The proteins in rubber seemed to polymerise and form additive compounds with sulphur. The hot sheet rubber leaving the calender was transparent, but soon became opaque. Some sulphur segregated, first in globules which slowly crystallised and grew at the expense of the other sulphur. The sulphuring or "blooming" of vulcanised rubber was due to sulphur coming to the surface; the bloom started frequently after wiping the rubber with a cloth. The bloom was due to combined sulphur; rubber containing an excess of free sulphur would be less liable to bloom, and ebonite would not bloom. The bloom sometimes also brought the dye used up to the surface; Mr. Anderson had not observed that minerals came up together with the sulphur, as was suggested during the discussion, which touched also on the acidity and various other features. Vulcanised rubber would only turn acid, Mr. Anderson thought, if it had been prepared with flowers of sulphur, not with precipitated sulphur.

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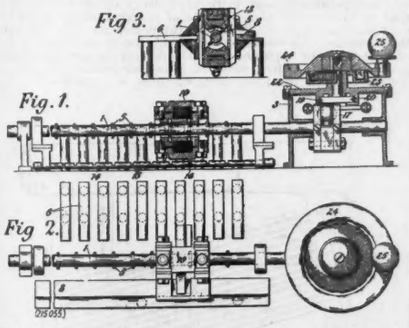
ELECTRICAL APPARATUS.

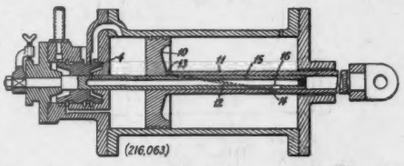
215,055. A. C. Smith, Shepherd's Bush. Electric Switches. (4 *Figs.*) January 26, 1923.—An electric switch in accordance with this invention comprises a plurality of fixed contacts disposed side by side, a contact traversable in relation to the row of fixed contacts, and means to traverse the movable contact in a step-by-step manner in relation to the fixed contacts comprising a rod having a compound movement consisting of an oscillatory or partial rotary movement and a longitudinal and reciprocatory movement, said two movements being imparted to it simultaneously, and said rod and movable contact having co-operating parts which are alternately engaged and disengaged by the oscillatory movement, and when engaged couple the rod and movable contact so that the longitudinal or reciprocatory movements of the former are transmitted to the latter. 1 is a rod mounted so as to be capable of rotary and endwise movements. The rod 1 has a series of pins 5 mounted diametrically on the rod and spaced at equal distances apart. 6 is a series of fixed contacts placed side by side and spaced apart the same as the pins 5. 8 is a fixed contact. 10 is the movable contact, the brushes of which bear on the contacts 6, 8. The contact 10 encircles the rod 1. The movable contact 10 is formed adjacent the rod 1 with two pairs of slots 13 disposed on opposite sides of the rod 1 and spaced the same as the pins 5. 14 is a second rod suspended from and below the rod 1 and raised or lowered as the rod 1 is rotated. The rod 14 has a plurality of slots 15, the spacing of which is the same as that of the pins 5. The movable contact 10 has a lug or projection 16 on its lower side which engages a slot in the rod 14. When the lug or projection is so engaged, the movable contact 10 is held against movement endwise of the rod 1. The movable contact 10 is released from the rod 14 by downward movement of such rod, such downward movement being due to its suspension which comprises a pair of eccentrics or cams. 17, 17 are a pair of arms mounted on the rod 1 and contained within the casing 3. The arms 17 are spaced apart and a ball is contained between and seated in recesses formed in the opposed faces of the arms 17. The ball is engaged by a pin 19 mounted on a crank 20. The crank arm 20 is mounted on a shaft that is carried in the cover 22 of the casing 3. The shaft carries a circular plate 23 in driving connection therewith and its upper face is formed with a circular groove that is stopped at one or two places.



24 is a circular plate or wheel provided with a handle 25. The wheel 24 is loosely mounted on a boss on the plate 23, and on its underside has lugs or projections that enter the groove in the plate 23. Between the stops in the groove of the plate 23 and the lugs, springs are placed. On rotation of the handwheel 24 in a clockwise direction by means of the handle 25, the shaft carrying the plate 23 is rotated in a like direction and imparts through the crank arm 20 and arms 17 oscillatory or partial rotary, and also longitudinal, movement to the rod 1. In the position of parts illustrated, the arms 17 are vertical and the pins 5 are in engagement with the slots 13 and occupy the position shown in Figs. 3. At the commencement and during the first part of the movement of the crank arm 20, the arms 17 are moved to one side of the vertical and the rod 1 is also moved in a rotary sense in a direction to cause the pins 5 to move towards the other ends of the slots 13. The bar 14 is also moved out of engagement with the lug or projection 16 on the movable contact 10 which is thereby unlocked and becomes free to be moved endwise with the rod 1. As the rotation of the shaft carrying the plate 23 continues, the rotary motion of the rod 1 is continued in the same direction until the shaft has moved through 90 deg. and it is also moved longitudinally to the right. When the shaft carrying the plate 23 is rotated through the second angle of 90 deg., the longitudinal movement of the rod 1 to the right is continued but its movement in a rotary sense is reversed with the result that when the shaft has completed 180 deg. of movement in all the pins 5 have again arrived at the positions in which they are shown in Fig. 3. During movement of the shaft through the first and second angles of 90 deg., the pins 5 through the longitudinal movement of the rod 1 act on and move the contact 10 to the right, the movement of the contact 10 being equal in distance to the pitch of the pins 5 During movement of the shaft through the third angle of 90 deg. the pins 5 are moved clear of the slots 13 by the angular movement of the rod 1, which movement is in the same direction as that which occurs during the second angular movement of 90 deg. of the shaft, but the rod 1 is moved longitudinally in the opposite direction, *i.e.*, to the left. The pins 5 being clear of the slots 13, the longitudinal movement of the rod 1 has no effect on the contact 10, which remains stationary. When the shaft is moving through the fourth angle of 90 deg. the rotary movement of the rod 1 is again reversed, while its longitudinal movement to the left is continued. At the completion of this fourth angular movement of the shaft the pins 5 and other parts occupy positions similar or corresponding to those in which they are shown in Figs. 1 to 3. It will thus be seen that the movable contact is moved a definite distance for each complete rotation of the crank arm. (*Sealed.*)

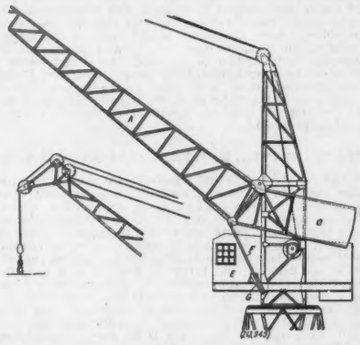
LIFTING AND HAULING APPLIANCES.

216,063. Norton's (Tividale) Limited,, Tividale, Tipton and H. Aughtie, Tividale, Tipton. Operating Reciprocating Conveyors. (4 *Figs.*) January 2, 1924.—The invention relates to motors for operating reciprocatory conveyors, and has for its object to control the valve so as to allow an infinitely variable stroke between limits. According to the invention, the piston rod 11 which is tubular is arranged to reciprocate on a hollow axially-rotatable guide spindle 15. Upon the inside walls of the piston rod 11 is formed a helical groove 12 which is open to the outside of said piston rod at 13, 14, or said helical groove may be an open slot throughout its length from the inside to the outside of the same. The guide spindle 15 towards its outward end is provided with an opening 16 which is adapted to register with the helical groove or slot 12. One



end of the guide spindle is open to one side of a distributing valve 4 controlling the inlet and exhaust of the pressure fluid. The piston 10 makes its outward stroke until a part of the helical groove or slot 12 in the piston rod 15 is brought into registration with the slot 16 in the guide spindle 15, whereupon pressure is relieved from the back of the valve 4, which is thus thrown over so as to open the exhaust. By partially rotating the guide spindle 15, the helical groove or slot 12 is brought into registration at a sooner or later period, and so the stroke is varied. The return stroke is effected by the gravity of the conveyor when the piston by mechanical means relieves the pressure from the front side of the valve which is consequently thrown over and opens the pressure inlet to the cylinder.—(*Sealed.*)

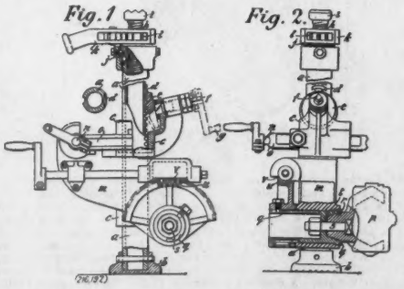
213,949. Stothert and Pitt, Limited, Bath, C. M. Toplis, Bath, and W. W. Padfield, Bath. Jib Cranes. (3 *Figs.*) July 6, 1923.—The invention relates to jib cranes. According to the invention, a bifurcated jib A, the two branches *a* of which are arranged one on each side of the machinery house E, is luffed by means of a link F pivoted to a convenient point on



the jib and to a crank G which can rotate through 360 deg. The crank may be carried on a mast above the jib, the link being connected to a point between the jib pivot and the jib head, or may, as shown, be mounted on the crane structure at any convenient point, the link being connected to the tail of the jib. (*Sealed.*)

MINING, METALLURGY AND METAL WORKING.

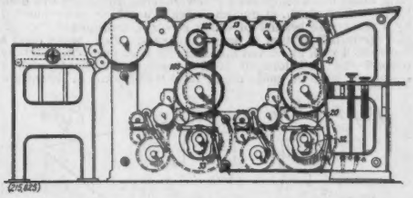
216,197. Sir W. G. Armstrong, Whitworth and Co., Limited, Newcastle-upon-Tyne, R. W. Wilson, Newcastle-upon-Tyne, and R. F. H. Hedley, South Shields. Coal Cutters. (2 *Figs.*) February 10, 1923.—The invention relates to stands for carrying coal cutters or the like, said stands being particularly suitable for carrying compressed air-driven percussion machines, for instance, such as the Hardy or Siskol type. *a* is a vertical column secured at its base to a serrated



base plate *b*. On the column *a* is a vertically slidable and non-rotatable sleeve *c* and also rack teeth *d* engaging a volute toothed bevelled pinion *e* on a spindle *f* carried in a bearing on the sleeve *c* and which can be turned by a handle *g*. At the upper end of the column *a* is a screw jack *h* having a head *i* which is moved vertically by a collar *j* threaded on the screw jack and rotated by a pawl carried by a swinging arm *k* and engaging with ratchet teeth *l* on the outer surface of the collar. On the sleeve is a bracket *m*, on which is a worm shaft *n* meshing with a worm wheel segment *o* fixed to the sleeve *c*, whereby the bracket *m* can be swung in a horizontal plane. The cutting machine *p* is carried by a short shaft *q* and secured therein by a conical projection *r* which is secured by a bolt *s* to a filling *t* in the short shaft *q*. Mounted on the short shaft *q* is a vertical worm wheel segment *u* meshing with a worm *v* carried by the bracket *m*, so that by rotating the worm *v* the cutting machine *p* can be swung in a vertical plane. (*Sealed.*)

PRINTING AND ALLIED MACHINERY.

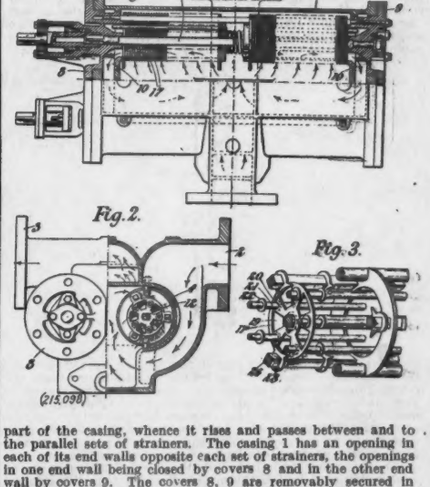
215,825. H. G. Rogers, South Lambeth. Printing Machinery. (1 *Fig.*) February 14, 1923.—A printing machine, according to the invention, comprises, in effect, two machines which are connected together by transferring and reversing cylinders by which sheets that have already been printed on one side in the first machine are passed to the second machine and, during their transfer, are reversed so that when passing through the second machine, they are printed on the other side. The sheets of paper issuing from the second machine pass to delivery mechanism and, it may be, to slitting, tucking and folding mechanism, either or both of which may be of any suitable construction. A printing machine, in accordance with this invention, comprises the combination of two stereo-carrying



cylinders 3, 103, an impression cylinder 2, 102 mounted in relation to each stereo-carrying cylinder, transferring and reversing cylinders 11, 13 disposed between the impression cylinders 2, 102 and means to move each impression cylinder before or at the commencement of each printing operation towards its co-operating stereo-carrying cylinder, and on the completion of each printing operation away from the co-operating stereo-carrying cylinder comprising two eccentrics, of which one is mounted on each end of the shift of each impression roller, said eccentrics being operated from cams 32, 33 through trip mechanism comprising a tappet lever 20 which is raised and lowered by the cam and a rod 21 connected at one end with the eccentric and detachably engaged with the tappet lever. (*Sealed.*)

PUMPS.

215,098. F. C. Fulcher, London. Straining or Filtering Apparatus. (8 *Figs.*) February 3, 1923.—According to the invention, a strainer for fluid is characterised by the fact that the straining wall is constituted of a plurality of thin discs or plates mounted side by side on a carrier and each having a hole or holes therethrough, separators disposed between adjacent discs or plates to space them apart and form an endless peripheral slot, the separators being either integral with the discs or plates and formed by pressing up the metal thereof, or separate from the discs or plates and constituted of, for example, washers, and a scraper blade or scraper blades of a thickness substantially equal to, but not greater than, the thickness of the separator or separators and mounted on a carrier and permanently engaging the slot, the discs or plates and the scraper blade or blades being relatively movable. 1 is a casing within which four strainers arranged in two sets are mounted. Each set comprises two strainers disposed end to end or in line, the two sets of strainers being disposed side by side and parallel to one another. The casing has an inlet 2 and an outlet 3, and, internally, a wall 4 which separates the inlet from the outlet and also serves to direct the entering fluid towards the lower

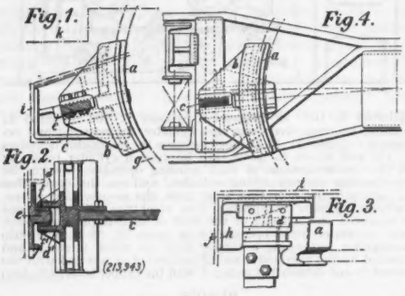


part of the casing, whence it rises and passes between and to the parallel sets of strainers. The casing 1 has an opening in each of its end walls opposite each set of strainers, the openings in one end wall being closed by covers 8 and in the other end wall by covers 9. The covers 8, 9 are removably secured in position and each is provided with a duct extending from its inner face to a groove 10 in a peripheral portion by which, when the cover is in position, connection is made with the outlet 3. 12 is a shaft rotatably mounted in the covers 8, 9. The shaft 12 serves to carry the two strainers constituting a set. Each strainer comprises a plurality of discs 17, each having a plurality of holes therethrough, namely, a centrally disposed hole of a section and size similar to that of the shaft 12, and by which it is mounted thereon and coupled thereto so that the rotary motion of the shaft 12 is imparted to the discs 17, and two circular rows of holes 19, 20. 21 are rods which are passed through the holes 20 and constitute carriers for the discs 17. The rods 21 also carry washers 22 which separate adjacent discs so that a slot is formed therebetween, the width of which is dependent on the thickness of the washers 22. As many discs 17 and washers 22 are placed on the shaft 12 and rods 21 as

are necessary to produce a strainer of the desired area. 26 are rods which extend the length of the casing 1 and are mounted at their ends in the covers 8, 9. The rods 26 constitute carriers for the scraper blades 28, each of which is formed of a piece of metal having a hole therethrough of a shape to permit it to be mounted on, and prevented from movement relatively to, the rod 26. There are as many scraper blades 28 on each rod 26 as there are slots formed by and between discs 17 and the scraper blades are positioned on the rods so that each enters a slot formed by and between adjacent discs 17. The scraper blades are of such formation that their operative faces or edges are oblique or inclined to the peripheries of the discs 17, so that when the discs 17 are rotated in relation thereto they will act to raise the fluff, dirt or suspended matter contained in the fluid being filtered or strained and intercepted by the edges of the discs away from the strainer. (*Sealed.*)

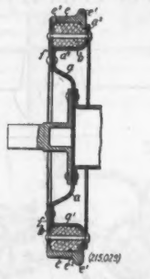
RAILWAYS AND TRAMWAYS.

213,943. Cammell Laird and Co., Limited, Sheffield, and A. S. Bailey, Sheffield. Brake Gear. (7 *Figs.*) November 7, 1922.—The invention relates to that kind of brake gear for railway and tramway vehicles wherein the brake blocks, when released, are allowed to move downward under the action of gravity and inclined guiding means into the off position. Each brake block comprises a renewable shoe *a* attached to a head *b*, any two of which, at opposite sides of a vehicle, are connected by a transverse beam *c* to which power is transmitted through an appropriate system of levers and rods. Each brake head *b* is provided with upper and lower flanges *d*, *d*1 projecting laterally beyond and well forward of the head to co-operate with a stationary slide or guide *e* and take the upward or downward



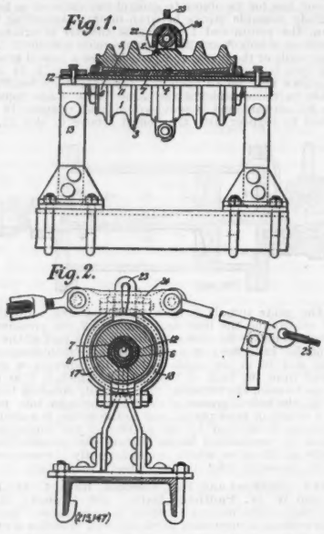
pressure exerted when the brake is applied. These flanges *d*, *d*1, or the slide *e*, may be provided with renewable wearing strips *f*, *f*1. The flanges and slide are, as shown in Fig. 1, inclined downwardly in a direction away from the wheel *g*, so that the combined blocks and transverse beam can move downward and into the off position under the action of gravity, when the braking power is removed. The lengths of the flanges and slide are chosen to maintain engagement throughout the maximum travel permitted. The slide *e* may, as shown, form part of the knee *h* for the solebar *i* and headstock *j* of a bogie, the whole arrangement being very compact and suitable in cases where the space available would make the use of suspension links extremely difficult. *k* indicates part of the lower portion of the body of a vehicle. (*Sealed.*)

215,029. Cammell, Laird and Company, Limited, Sheffield, and A. S. Bailey, Sheffield. Wheels and Axles. (4 *Figs.*) November 7, 1922.—The invention relates to wheels suitable for use with railway, tramway and like vehicles. The invention has reference to improvements in wheels of the kind in which a rubber ring is arranged between the wheel rim and tyre. For this purpose, a wheel, according to the invention, comprises a wheel centre or body *a* having a plain rim *a*1 with an outwardly extending flange *a*2 at one side thereof, a metal tyre *c* having an outwardly extending flange *c*1 at one side thereof, and an annular groove *c*2 on its inner side, a ring of rubber *b* held under compression between the wheel rim *a*1 and the grooved under surface of the tyre *c* so as to form an effective elastic cushion for the tyre, and a lateral ring *f* for holding the rubber ring *b* and the tyre *c* laterally in position on the wheel



rim *a*1 and for holding the rubber ring *b* in a compressed condition. To enable the rubber ring *b* to be readily inserted into the internal annular groove *c*2 in the tyre it may be made in segments. The rubber ring may be placed under compression by pressure caused to act thereon in a radial outward direction in the operation of inserting the rubber ring between the wheel rim and tyre so that it can at once firmly hold the tyre to the wheel rim and form a very effective cushioning device between the two. To enable this result to be attained, the internal diameter of the rubber ring may initially be of less diameter than the external diameter of the wheel rim. The compressed rubber ring is held laterally in place on the wheel rim between the outwardly extending flange *a*2 at one side thereof and the retaining ring *f* at the opposite side, bolts or screws extending laterally through the flange, rubber ring and retaining ring. (*Sealed.*)

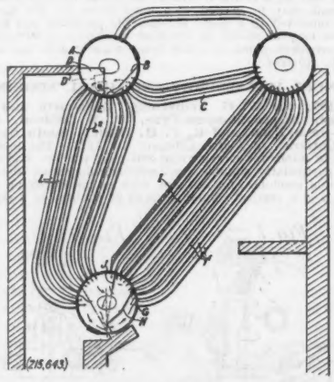
215,147. Sir P. Dawson, Westminster, London, and F. W. Fawdry, South Kensington. Electric Railways. (3 *Figs.*) March 9, 1923.—The invention relates to devices for supporting the catenary and conductor wires on electric railways, tramways and the like. According to the invention, a supporting device for overhead conductors on electric railways is provided wherein clamping members to which catenary wires are connected are seated around an insulator sleeve in such a manner that the clamping members can expand freely without exerting any tensile stress on the insulator sleeve. The insulator 1 is of substantially cylindrical form externally having a central circumferential ridge 2 with inclined sides and two or more circumferential flanges 3. The insulator 1 has a central longitudinal cylindrical passage 4, the ends of which may be coned outwardly as shown at 5. The sleeve thus constituted is carried on a metallic tube 6, the relative dimensions of sleeve 1 and tube 6 being such that resilient packing material 7 may be interposed between them. Further, a secondary insulator may be provided by placing an insulating tube 11 between the metallic tube 6 and the porcelain insulator 1. The tube 6 is mounted upon a spindle 12, the ends of which are carried in standards 13. A clamp formed in two



parts 17, 18 surrounds the central ridge 2, the members of the clamp being formed internally with sloping faces adapted to engage the inclined sides of the ridge 2, and thus prevent lateral movement of the clamp and causing only compressional stresses on the ridge 2 when the clamp is tightened on the insulator. The ends of the clamping members 17 and 18 are connected together by bolts and nuts disposed above and below the insulator, the two upper ends of the clamping members 17 and 18 engaging between them a shackle 22 having an upwardly extending slotted lug 23 over which is passed a saddle 24, to which the ends of adjacent spans of catenary wire 25 are connected. (*Sealed.*)

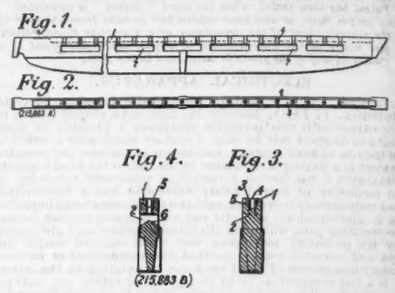
STEAM ENGINES, BOILERS, EVAPORATORS, &c.

215,643. The Stirling Boiler Company, Limited, London, and E. E. Noble, Fulwell, Sunderland. Water-tube Boilers. August 22, 1923.—The invention relates to water-tube boilers of the vertical or semi-vertical curved or straight tube type. There is provided in the rear upper drum A a splash plate B covering the cross-over water circulating tubes C, such splash plate extending for the greater part of the length of the drum A, but being cut away at both ends to uncover at least two cross-over tubes at each extremity. In the drum A are mounted two feed boxes D, one at each side of the centre, leaving uncovered one, two or even three rows of tubes L adjacent to the relative drum end between each box and the relative drum end. In the boxes D are the usual feed troughs D1. The boxes D are connected by a balancing pipe. E



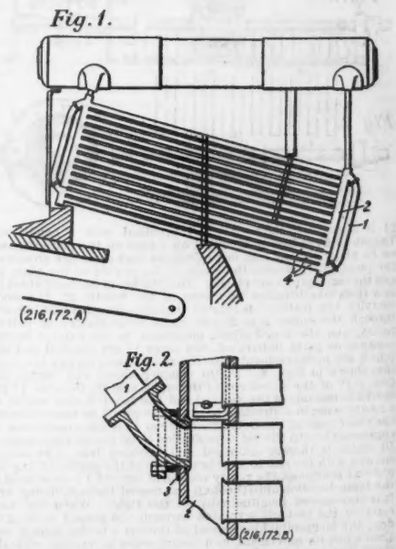
denotes an angle mounted on the drum bottom and connecting the boxes D and forming a small "wall" in front of the tubes L2 of the foremost row of tubes of the rear bank L into the middle portion of the length of the drum. In the mud drum G is fitted a baffle H which may be straight, curved or bent and which covers entirely two, three or four rows of the tubes I1 of the front bank I next the combustion space of the boiler. The baffle H forms one side of a box closed at the ends but open at the bottom. J denotes a narrow baffle plate extending the whole exposed length of the mud drum G between the rear-most row of front bank tubes on which rest the usual baffle tiles and the next row of front bank tubes. The plate J is inclined in such manner that a continuation of the plate J would meet the lower edge of the baffle H. (*Sealed.*)

215,883. A. T. Patterson, New Brighton. Furnace Fire-Bars. (3 *Figs.*) March 5, 1923.—The invention relates to furnace firebars having a longitudinally-extending channel or channels in the top or fuel-supporting part of the bar. The top of the firebar has a channel (or channels) 1, that extends the full length of the fuel-supporting surface, and transverse slots or passages 2, spaced at regular intervals apart, are formed right through the upper portion of the bar at a suitable level below the top surface thereof. In the longitudinal channel 1 is housed an insert or filling-piece 3, moulded from fireclay or other suitable refractory material. This insert 3 may be moulded and baked *in situ* in the channel. The insert is formed with a series of vertical holes or tubular passages 4 in it, which communicate when the insert is in position in the firebar, with the transverse slots or passages 2 by means of metal tubes 5 secured in holes that connect the bottom of the channel with the transverse slots or passages 2. Air can thus pass from each side of the firebar into the transverse slots or passages 2, and up through the tubes 5 to the fuel on top of the bar. It will be seen that the upper portion of the metal firebar virtually forms a frame-



work adapted to house the fireclay insert or other fuel-supporting bed, and provide air-ways for the passage of air to the fuel on the top of the bar. The insert, as also the channel, may be of any suitable form in cross-section. For example, the insert may be of dovetail form in cross-section and narrowed in width upwards, so that the insert is locked or keyed in position. Further, the vertical air passages may be made so as to increase in width downwards. Instead of using a moulded insert of refractory material as described, the channel or channels in the top of the firebar may have an ash filling, as commonly used in channelled firebars, the tubes 5 passing up through this ash bed in the channel. The bottom of the transverse slots 2 may be a flat or horizontal surface, as in Fig. 3, or be made of ridged form as shown at 6, in Fig. 4. In this latter construction, the sloping surfaces tend to prevent ash lodging thereon and choking up the space, and will also serve to direct the draught to the tubes. (*Sealed.*)

216,172. The London Electric Supply Corporation, Limited, London, and A. G. Fox, New Cross, London. Steam Generators. (6 *Figs.*) January 18, 1923.—The invention relates to steam generators of the water tube sectional header type. The object of the invention is to provide improved means whereby the circulation through the lower rows of tubes in boilers of the type described having headers divided into compartments, and more particularly of existing boilers may be increased so that the rate of evaporation of the water may be raised without damage to the generators. To this end the invention consists in connecting the lower and upper ends of the headers by means of external tubes arranged substantially parallel to the headers, so as to form independent circulating system between the lower rows of tubes and the drums. In



carrying this invention into effect according to the arrangement illustrated a number of tubes 1 is provided which are arranged substantially parallel to the header 2, at the rear end of the boiler; the upper ends of these tubes may be connected to the upper end of the header, and the other end to the lower end of the header, the connections being readily made by utilising the cap holes 3, which are usually provided in such headers. The external tubes 1 only supply water to the rows of tubes 4 entering the header at the lower end, for example, the three lowermost rows. Above these rows within the header a dividing plate or baffle 5 is provided which prevents the water entering the header direct, from descending as far as the bottom rows, and also prevents the water entering through the external tubes 1 from rising to supply tubes situated above the baffle. (*Sealed.*)